Atlantic Salmon Conservation Plan

for

Seven Maine Rivers

prepared by

The Maine Atlantic Salmon Task Force

March 1997

ACKNOWLEDGEMENTS

The Conservation Plan is the product of many individuals and organizations who contributed directly to its content as well as those people who suggested changes during the review process. More than 75 men and women participated on the Task Force and the six Working Groups over an 18 month period to complete the Plan.

Additional support for the Plan came from numerous state agency personnel, federal employees, a variety of river and angling conservation organizations as well as industry. The Plan could not have been completed without all of their help.

It is important to realize that the Plan is dynamic and that scores of people have already initiated programs called for in the Plan. It is a working document, not a concept.

To all of you who participated, Thank You, we could not have done it without your help.

Atlantic Salmon Task Force Members

Commissioner Ray B. Owen, Chair
Department of Inland Fisheries & Wildlife

Commissioner Robin Alden
Department of Marine Resources

Chuck Gadzik, Director
Maine Forest Service

Peter Mosher
Department of Agriculture

Brian Stetson
Great Northern Paper Company, Inc.

William J. Vail
Maine Forest Products Council

John Albright
Atlantic Salmon Federation

John Banks
Department of Natural Resources,
Penobscot Indian Nation

Robert Cope / Gary Donovan
Champion International

Gary Willey
Jasper Wyman & Sons

Ragnar Kamp
Cherryfield Foods

Steve Swartz
Kennebec Aquaculture

Irv Kornfield
University of Maine, Department of Zoology

Francis Reynolds
Atlantic salmon angler

Elizabeth Butler
Office of the Governor

Henry Nichols, Staff
Atlantic Salmon Task Force

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I. Introduction

The Maine Atlantic Salmon Conservation Plan ("Plan" or "Conservation Plan") is the product of a collaborative effort between the public and private sectors to design an effective plan for the conservation and restoration of salmon runs in seven Downeast rivers in Maine. These rivers include the Dennys, Machias, East Machias, Narraguagus, and Pleasant Rivers in Washington and Hancock Counties and the Ducktrap and Sheepscot Rivers in Lincoln, Kennebec, Sagadahoc, Knox, and Waldo Counties. The Plan builds upon the strong foundation of Maine's long-standing commitment to restoration of salmon to natal habitat and to identify the needs of the species. But the Plan and its implementation breaks new ground with a key innovation: a comprehensive review of the watersheds by a team of citizens (who know and use the resources in the watershed) to fashion a systematic plan to minimize adverse human impacts on the species and restore salmon through a series of reasonable and affordable measures. Maine believes that this collaborative and innovative approach to protection and restoration of salmon is vital to maintaining the commitment of Maine citizens to this important natural resource. Importantly, the Plan includes a novel restoration project for these salmon runs using the expertise of Maine's salmon aquaculture industry, a project that may serve as a model for future restoration efforts.

The Plan has been fashioned in the context of Maine's current comprehensive regulatory framework to protect salmon and its habitat, as well as a general scientific consensus that the driving forces in the decline of this species on these rivers are beyond the jurisdiction of the State of Maine. The decline in the Downeast river stocks reflects an overall decline in North American Atlantic salmon stocks, and likely represents a cyclical stock fluctuation strongly influenced by low marine survival beyond Maine territorial waters and over fishing on the high seas. This is confirmed by the fact that these seven Downeast rivers are non-industrial rivers, relatively uninfluenced by the history of industrial pollution and hydropower typical of many other salmon rivers. While forces beyond the control of the State of Maine will ultimately determine the fate of the salmon runs, the Conservation Plan is designed to assure that Maine has taken all reasonable steps to assure successful restoration if and when the international commercial fishing and ocean temperature conditions improve.

The Maine Atlantic Salmon Conservation Plan arose out of an October 20, 1995 Executive Order by Governor King appointing the Maine Atlantic Salmon Task Force and charging that Task Force with preparation of a conservation plan for the protection and recovery of Atlantic salmon in the seven rivers. The Task Force was formed in response to a proposed listing of Atlantic salmon in the seven Maine rivers as threatened under the federal Endangered Species Act. The Task Force included scientists, academics, state employees, Native American sustenance fishers, conservationists, and private citizens knowledgeable about the salmon resources in these rivers. The Task Force organized its effort through six working groups: genetics, aquaculture, agriculture, forestry, recreational fisheries, and the "four rivers" to address the specific issues on each of the seven rivers as well as similar issues on the Kennebec, Penobscot, and St. Croix Rivers and Tunk Stream. The working group reports of all committees guided the Task Force's final product, but only the reports of the agriculture, aquaculture, forestry, and recreational fishing have been included as attachments to this Plan. The Plan includes a systematic overview of the potential threats to salmon and its habitat in these rivers, the most efficient methods of minimizing or eliminating those potential threats, and the most effective methods to restore river-specific stocks. In addition, the Task Force developed a comprehensive plan for education of all citizens about the conservation issues. This Executive Summary provides an overview of the detailed Conservation Plan of the Atlantic Salmon Task Force and its working groups.

II. Background

A. Past and Ongoing Atlantic Salmon Management

In 1945 the Maine legislature created a single administrative unit within state government with authority to manage Atlantic salmon in both fresh and salt water**.** Formerly known as the Atlantic Sea Run Salmon Commission, this agency was superseded in 1995 by the Atlantic Salmon Authority (ASA). Some of the key management activities undertaken by the Atlantic Sea Run Salmon Commission during the period of 1947-1995 included Atlantic salmon habitat surveys and habitat improvement measures, fish passage improvements at natural and constructed barriers, water level control programs, the elimination of commercial fishing, progressively restrictive sport fishing regulations, and various stocking programs utilizing hatchery-reared stocks. The Commission=s research activities initially focused upon Maine Atlantic salmon life history data and population monitoring studies that were crucial to future restoration and management programs. Additional important research initiatives included studies to evaluate stocking methods and practices, impacts of natural predation, and tagging studies that documented the marine migrations and exploitation of Maine salmon stocks in the commercial fisheries of Canada and Greenland. The Atlantic Sea Run Salmon Commission=s 25-year Carlin tagging database was instrumental in documenting the high exploitation rates that Maine-origin salmon stocks were subjected to in distant water commercial fisheries.

The increased production of hatchery-reared salmon, in addition to improved water quality, new or improved fish passage facilities, and reductions in distant water commercial fisheries, dramatically increased Maine salmon runs and sport fisheries during the 1970s and 1980s. Habitat accessibility and adult Atlantic salmon returns to Maine increased tenfold. However, the survival of both wild-origin and hatchery-origin salmon has exhibited a declining trend since the mid-1980s. The Atlantic Salmon Authority has documented this decline through long-term angling catch data, counts of adult salmon, redd counts, and juvenile population assessments. Comparable reductions in marine smolt survival and adult salmon abundance have been demonstrated in most other North American salmon stocks, and there is general agreement among fishery scientists that this recent period of low marine survival during the first winter at sea is negatively impacting Atlantic salmon stocks over a broad geographical area.

The overall management strategy in effect since 1992 for the seven Downeast rivers has been to maximize the production of wild Atlantic salmon smolts by restocking with river-specific stocks, with an emphasis upon fry releases. The goal for each of the seven rivers is to rebuild naturally-reproducing Atlantic salmon populations to levels where stocking will no longer be necessary on a continual basis. From a fisheries restoration and management perspective, these efforts will influence the Maine Atlantic salmon restoration program well into the 21st Century, since a long-term commitment is required to develop the necessary stocks, and several generations of adult returns will be required to rebuild Atlantic salmon populations.

The Atlantic salmon stocks in the seven Downeast rivers have been, and will continue to be, a high priority for the State of Maine, and the protection, conservation and rehabilitation of salmon habitat and populations in these rivers are the primary focus of this Conservation Plan. The current management goal for the seven rivers is to produce a minimum annual *total* return of approximately 2,000 adult Atlantic salmon. This goal requires a biologically-based minimum spawning escapement of 1,452 multi sea winter salmon annually (based upon a minimum egg deposition of 2.4 eggs/m^2 of habitat), which should result in the combined production of 65,325 smolts (@ 3.0 smolts/unit) in the seven rivers (see Table 1). Additionally, the long-term goal for these rivers includes the provision for a minimum recreational harvest of 445 adult salmon (based upon historical sport catches) above and beyond spawning requirements.

Table 1. Atlantic salmon management goals for seven Downeast rivers.

River	Drainage Area (mi²)	Units of Habitat (100m²)	Smolt production Goals (3.0/unit)	Minimum Spawning Requirement (MSW[1])	Recreational Harvest Goal	Minimum Total Run
Dennys	132	2,415	7,245	161	75	236
East Machias	251	2,145	6,435	143	50	193
Machias	460	6,685	20,055	446	150	596
Pleasant	85	1,085	3,255	72	25	97
Narraguagus	232	6,015	18,045	401	100	501
Ducktrap	36	585	1,755	39	20	59
Sheepscot	226	2,845	8,535	190	25	215
Total	1,422	21,775	65,325	1,452	445	1,897

[1] Based on egg deposition of 2.4 eggs/m ^{2}, 7,200 eggs/MSW (multi-sea-winter) female, 50/50 sex ratio

The management strategy to advance the recovery of these seven rivers will continue to include: annual plans for stock assessment; habitat inventory, protection, and rehabilitation; and developing and maintaining adequate river-specific broodstocks. Acquisition and development of river-specific broodstocks for the seven rivers in recent years have already resulted in the collection of 76 adult sea run salmon from three rivers and nearly 4,000 wild salmon parr from six of the rivers for broodstock rearing programs. These broodstock sources have produced more than 2.1 million salmon eggs to date, resulting in the stocking of more than 1.2 million river-specific salmon fry and 2,000 river-specific smolts in five of the rivers. Numbers of fry available for stocking in future years is expected to continue to increase substantially. Although the Atlantic salmon nursery habitat in three of the rivers is approaching full production, juvenile salmon populations will continue to be monitored annually to evaluate the results of fry-stocking efforts and to document the extent of habitat utilization in the seven rivers.

While the Atlantic Salmon Authority will have stock management authority for all Maine rivers after July 1, 1997 (the seven rivers remain under the Departments of Inland Fisheries and Wildlife and Marine Resources jurisdiction until July 1, 1997). The restoration and rehabilitation of Atlantic salmon runs on the seven rivers will involve longstanding, complex working relationships and partnerships between numerous state and federal agencies and private sector groups. The State of Maine will actively build an integrated and coordinated watershed approach to rehabilitate these salmon stocks - including voluntary measures provided by numerous public and private entities - to maximize the benefit for the resource. Given the extensive involvement of many state and local agencies, the Land and Water Resources Council of the Executive Department will supervise the Conservation Plan Coordinator, in consultation with the Atlantic Salmon Authority. The Atlantic Salmon Authority will be included in the Land and Water Resources Council salmon and salmon habitat activities. The Atlantic Salmon Authority will also continue to work closely with United States Fish and Wildlife Service personnel in the ongoing rehabilitation programs for the seven rivers in areas such as monitoring adult salmon runs, broodstock collection, river-specific stocking, Atlantic salmon habitat surveys, evaluation of natural reproduction, public education and outreach, and genetic characterization studies. Similarly, the Atlantic Salmon Authority will work closely with National Marine Fisheries Service personnel in identifying and quantifying the cause(s) of the observed declines in the marine survival of wild smolts produced in the seven rivers.

Several new Atlantic salmon restoration/rehabilitation initiatives are described in detail in this Conservation Plan. Initiatives with the agriculture, aquaculture, forestry, and recreational fishing interests are expected to contribute to the protection of Atlantic salmon habitat and the enhancement of adult salmon runs and spawning escapement in the seven rivers in future years - examples include: conservation easements and habitat protection agreements with landowners, water-use inventory and management plans, agricultural land use inventories, and pen rearing of adult salmon by Maine=s aquaculture industry. Again, it should be emphasized that while protecting freshwater populations and habitat will contribute to restoring Atlantic salmon in the seven Downeast rivers, success depends primarily on increased ocean survival.

B. Existing regulations

State of Maine laws and regulations, in combination with existing federal, interstate, international and cooperative agreements and requirements, provide a comprehensive regulatory framework to protect Atlantic salmon and its habitat. Federal, state and local regulatory mechanisms provide a full array of protection against virtually any activity which could contribute to the decline of the salmon population, including: protection against siltation, erosion and sedimentation; protection against adverse water quality impacts; protection against pesticide drift; controls on timber harvest in shoreland areas; controls on construction; review of reconstruction or alteration of hydro-electric facilities; and provision for fish passage. In addition, the State of Maine has a broad array of statutory and regulatory provisions administered by several state agencies designed to protect, enhance and restore salmonid populations to Maine rivers. In sum, the State of Maine is a leader in affording protection to sensitive species through controls on harvest, waste discharge, water quality, development, forestry and hydropower.

A comprehensive list of the existing regulatory mechanisms in the State of Maine protecting Atlantic salmon follows. Each Working Group Report contains a description of the applicable rules and regulations. With the implementation of this Conservation Plan, the State of Maine will go beyond this regulatory framework of protective laws and create affirmative habitat enhancement and restoration opportunities.

The existing regulatory framework to protect salmon includes the following laws and associated implementing regulations:

<u>Maine Laws and Regulations</u>

A. Department of Conservation

1. Land Use Regulation Law, 12 M.R.S.A. '' 681-689
2. Forest Practices Act, 12 M.R.S.A. '' 8867-8869
3. Forest Product Refuse Act, 38 M.R.S.A. ' 417

B. Department of Marine Resources

1. Fishways Laws, 12 M.R.S.A. '' 6121-6125
2. Commercial and Sport Fishing Limits, 12 M.R.S.A. ' 6553
3. Importation, 12 M.R.S.A. '' 6071(4)

C. Maine Department of Inland Fisheries and Wildlife

1. Fish hatcheries laws, 12 M.R.S.A. '' 761-7675
2. Fishways and Dams Laws, 12 M.R.S.A. '' 7701-A to 7702
3. Atlantic salmon Laws, 12 M.R.S.A. ''9901 to 9907

D. Maine Department of Environmental Protection

1. Maine Rivers Laws, 12 M.R.S.A. '' 401-407
2. Water Quality Laws, 38 M.R.S.A. '' 361-372, 401-424, 451-452, 464-470, 571
3. Mandatory Shoreland Zoning Act, 38 M.R.S.A. '' 435-449
4. Natural Resources Protection Act, 38 M.R.S.A.'' 480-A to 480-U
5. Site Location of Development Law, 38 M.R.S.A. '' 481 to 490-J
6. Maine Waterway Development and Conservation Act, 38 M.R.S.A. ''630-637, 640
7. ME Dam Registration, Abandonment and Water Level Act, 38 MRSA ''815-818,830-843
8. Oil and Hazardous Materials, 38 M.R.S.A. '' 543-550

E. Atlantic Salmon Authority , 12 M.R.S.A. '' 9901 to 9907

F. Maine Department of Agriculture Food and Rural Resources

1. The Right to Farm Law, 17 M.R.S.A. '' 2805
2. Board of Pesticide Control Laws, 7 M.R.S.A. '' 601-625, and 22 M.R.S.A. '1471
3. Manure Handling and Spreading Laws , 38 M.R.S.A. '' 2701-B, 417-A

In addition, the State of Maine participates in the following commissions and public-private agreements to protect salmon and habitat:

1. Agreement between the State of Maine and the Kennebec Hydro Developers Group
2. Project SHARE
3. Saco River Agreement
4. St. Croix International Waterway Commission
5. North Atlantic Salmon Conservation Organization
6. New England Atlantic Salmon Committee
7. Agreement between the State of Maine and the U.S. Fish and Wildlife Service
8. New England Interstate Water Pollution Control Commission
9. Maine Indian Tribal State Commission

C. Genetics and the Rationale for River Specificity

The Genetics Committee of the Task Force carefully examined all available information on Atlantic salmon and evaluated it in the light of current population and evolutionary theory. This report has been submitted to the federal government under separate cover to explain the State of Maine's opposition to the proposed listing of salmon under the Endangered Species Act. The genetic issues underlying the management of the Maine's Atlantic salmon are very complex; there are significant differences of opinion among scientific experts in data interpretation and, particularly, underlying assumptions. The complexity of the science involved makes it difficult to provide simple answers to seemingly simple questions. Despite this disagreement, the State of Maine and the United States Fish & Wildlife Service and the National Marine Fisheries Service agree that river-specific management is the most scientifically prudent approach in order to protect any local adaptations, consistent with the long-established management plans for these rivers, and is reflected in the Plan.

From ecological and evolutionary perspectives, river-specific management is currently viewed by the scientific community as the best available strategy to promote restoration of the resource. The evidence indicates that restocking efforts are most likely to succeed when donor fish come from the rivers to be stocked, provided that an adequate number of broodstock are available to preclude undesirable genetic consequences such as inbreeding. River-specific stocking promotes local adaptation, a critical component for long term restoration, and insures that genetic traits that may potentially be present (but which can not be visualized with currently available methods) will also be retained. In the absence of such management, local adaptation is not possible and any potential survival advantage is lost.

Thus, river specific management is the most scientifically prudent approach. After extensive review, the community of Atlantic salmon fisheries scientists and managers agreed to adopt a river-specific stocking program in 1991; this carefully considered approach clearly predates the current debate on the status of the species in Maine. River-specific stocks are currently in culture, and have been stocked in several rivers for the past few years. It is clear that we are dealing with a dynamic biological system that may change over time. Thus, as part of the proposed management plan, results from the river-specific stocking program will be monitored on an on-going basis and will be critically reviewed in 2003. For example, once the genetic information is available for the Pleasant River, the Atlantic Salmon Authority, after consultation with federal authorities and other interested parties, will decide whether to continue the current program or introduce mixed stocks to increase genetic variability.

D. Justification for Weirs

The construction, operation and maintenance of weirs in the Dennys, East Machias, Machias, Pleasant, and Narraguagus rivers are integral components of the Conservation Plan. The weirs will perform several critical functions for the recovery of Atlantic salmon in these five Downeast rivers. First, they are a location where the Atlantic Salmon Authority can collect valuable data such as the numbers, source, and condition of returning adults. This information is necessary to help the Atlantic Salmon Authority adjust each rivers annual stocking requirements and escapement goals. Second, by excluding aquaculture escapees between May 1st and November 1st, the weirs will help minimize any potential of interbreeding and habitat competition between farmed fish and river specific fish. Farmed fish passing the weir station after November 1st will have a greatly reduced chance of successfully spawning. Third, the weirs will provide an opportunity to collect broodstock, a task vital to the restoration effort. Broodstock can be collected using other techniques, but not as efficiently as at a weir. Finally, the weirs can be constructed with state of the art technology and operate continuously and effectively without compromising wild, river-specific Atlantic salmon's ability to migrate upriver or head out to sea. After evaluation of these weirs, the Atlantic Salmon Authority may consider installing a weir on the Sheepscot River to aid their fish management efforts. A weir on the Ducktrap is unnecessary as redd counting and observation provide adequate fish management data.

III. Overview of Threats to Atlantic Salmon

The Atlantic salmon has a complicated life cycle, inhabiting both freshwater and marine environments. Juvenile salmon spend several years in fresh water and then as smolts migrate from rivers and streams to oceanic feeding areas thousands of miles away. Adults return to spawn in the same streams 1 to 3 years later. Factors such as stream hydrology, seasonal water temperatures, pH, dissolved oxygen, streambed characteristics, availability of food, competition, predation, pollution, recreational angling, and illegal harvest all affect juvenile, adult, and migratory smolt survival in rivers and streams.

Similarly, water temperature, food availability, competition, predation, and commercial fisheries influence the salmon's survival at sea. Atlantic salmon are also susceptible to a variety of bacterial, viral, and fungal diseases and parasites. Although human activities have significant potential to influence Atlantic salmon populations, people cannot control other circumstances affecting populations. For example, global climate influences ocean surface temperatures, the timing and amounts of precipitation, and groundwater temperatures, thus influencing the ability of marine and freshwater habitats to support salmon.

The most obvious effect of human activity is the death of individual fish. Adult Atlantic salmon can die from a directed recreational harvest (very limited in Maine) or may perish after fish are hooked. Some illegal harvest of adult salmon also occurs on Maine rivers. Commercial fishing operations located in the migratory path of Atlantic salmon may also incidentally catch salmon as they harvest other species. Despite careful handling, fish may die from trauma when fisheries biologists capture salmon to collect necessary growth and population data.

A wide range of chemicals, including petroleum products, pesticides, and metals, are toxic to Atlantic salmon. Legal and illegal solid waste management practices, long range atmospheric transport, direct discharges, and accidental spills are a few of the potential sources of surface or groundwater contaminants. Atlantic salmon mortality occurs when concentrations exceed lethal thresholds; however, lower concentrations affect physiology and behavior. Sublethal levels of pollutants, water temperature, and dissolved oxygen are examples of environmental stresses that, combined with normal exposure to pathogens or parasites, can increase the likelihood of disease. Poor culture practices in fish hatcheries and pen culture in an Atlantic salmon watershed could increase the risk of a wild population's exposure to pathogens and parasites.

Atlantic salmon require cool, well-oxygenated streams with coarse gravel beds and suitable water depths and velocities. The proportion and distribution of different land uses within a watershed influence their cumulative effects on these habitat characteristics. Habitat is lost to Atlantic salmon production if dams, road culverts, pollutants, elevated water temperatures, or reduced stream volume block or delay adult passage to spawning areas. Habitat area and quality are reduced when water is withdrawn during low flow periods. Sediment eroded from roads, cleared and developed land, agricultural fields and pastures, and poor forestry practices fills spaces in gravel streambeds, reducing productive capacity. Excessive nutrients increase aquatic plant growth, changing streambed characteristics. Direct discharges of organic material from hatcheries, sewage treatment plants, manufacturing or processing plants can reduce dissolved oxygen concentration. If streamside shade is removed or streams are impounded, summer water temperatures can increase, reducing oxygen solubility. Elevated average or maximum temperatures, whether because of land use changes or heated discharges, directly affect Atlantic salmon behavior and may affect survival.

The small Atlantic salmon populations surviving in the seven rivers may be at risk from detrimental changes in their genetic makeup. Small populations increase the chances of random changes in gene frequencies (genetic drift). Genetic drift can undermine existing, local adaptations. Similarly, the probability of inbreeding (mating between closely related individuals) increases. Wild fish may lose local adaptations if they interbreed with fish from different rivers or of aquaculture origin. In addition, landlocked Atlantic salmon or brown trout spawning with sea-run salmon may produce fertile offspring. Although aboriginal stocks no longer exist in these seven rivers, it is prudent to continue river-specific stocking to promote any existing local adaptations.

Human management and exploitation of natural resources have altered the ecology of Atlantic salmon habitat. Decades of fisheries and wildlife management practices have affected the species composition and population sizes of competitors and predators. For example, fisheries managers in Maine introduced brown trout and splake, potential competitors of Atlantic salmon, to provide recreational fishing. Smallmouth bass, a predator of parr and smolts, is also an introduced species. Biologists and local observers have long recognized that seals and double crested cormorants prey on salmon. Federal law now protects them and their populations are expanding. Beaver populations increase as demand for their fur decreases. This results in more beaver dams limiting Atlantic salmon access to habitat. Commercial fisheries may have affected the availability of estuarine and oceanic food for Atlantic salmon.

The federal Status Review of salmon populations of the seven rivers (60 Fed. Reg. 50532 (September 29, 1995)) discusses many of the factors affecting salmon populations mentioned above. It identifies forestry, recreational fishing, agriculture, and aquaculture as topics for in-depth conservation planning. Detailed discussions of how the Atlantic salmon and its habitat are affected by these activities and the proposed actions to minimize threats are in the working group reports. Summaries of the status of each activity in the seven river watersheds, potential threats to Atlantic salmon and its habitat, current actions addressing potential threats, and the actions proposed to reduce potential threats to Atlantic salmon follow. Readers should recognize that the proposed actions are supplemental improvements to the strong network of federal, state, and local laws and volunteer initiatives already at work in the seven river watersheds.

IV. Proposed Actions to Reduce Potential Threats to Atlantic Salmon and Its Habitat

A. Agricultural Activities

Status of Agriculture

The proposed listing and Conservation Plan initiative provided the Agriculture Working Group the opportunity to develop and implement actions that would benefit both Atlantic salmon and Maine's agricultural resources in the Sheepscot, Ducktrap, Narraguagus, Pleasant, Machias, East Machias, and Dennys River watersheds. In these watersheds, agriculture includes a complex list of activities directed at producing crops and animals, or their by-products, for human use. In addition, crops must be transported, processed and marketed. A list of the types of agricultural activities and/or products in these watersheds includes: dairy farming, hay, silage corn, horse farming, sheep farming, beef cattle farming, Christmas trees, market vegetables, blueberries, cranberries, landscape and horticultural plants, and peat mining.

Wild blueberry culture is the primary form of agriculture in the five Washington County watersheds (Narraguagus, Pleasant, Machias, East Machias, and Dennys). The Narraguagus River watershed also contains the only active peat mine in the seven watersheds. Currently, there are 60 acres in cranberry culture statewide, with less than 20 acres in the seven watersheds, although more is anticipated. In the Sheepscot River watershed livestock production is the predominant form of agriculture. In all the seven watersheds combined, there are probably less than 400 acres in Christmas trees. The Ducktrap River watershed does not contain significant amounts of agriculture.

Potential Threats to Atlantic Salmon and Its Habitat

Current agricultural practices in Maine are not considered a major threat to Atlantic salmon (60 Fed. Reg. 50532 (September 29, 1995)). The Agriculture Working Group identified potential threats to Atlantic salmon related to agricultural activities. While it was unlikely that the identified activities would directly cause Atlantic salmon mortality, they did have the potential to affect habitat quantity and quality. Therefore, the focus was on minimizing the threat from agriculture to Atlantic salmon habitat.

Activities that had similar effects on Atlantic salmon habitat were grouped. As a result there are three categories addressed; Water Use, Agricultural Practices, and Peat Mining. Irrigation and use and disposal of process water are discussed within the Water Use section. The Agricultural Practices section includes most of the activities involved with crop production that may cause non-point source pollution. Direct discharge from agricultural processing plants is also included. Peat mining warranted a separate section because the effects on stream hydrology and water quality were very different. For each of the three categories the Working Group identified existing programs that minimize the threat from agricultural activities to Atlantic salmon habitat. Where existing programs were incomplete they proposed enhancing existing programs or developing new actions to reduce threats.

Current Actions Addressing Threats:

* Integrated Crop Management (ICM) and Best Management Practices (BMPs) for blueberry and cranberry production with the leadership of Maine Cooperative Extension.

* The Non-point Source (NPS) program and the Coastal Zone Management (CZM) program with BMPs to protect water quality.

* The Generic State Management Plan for Pesticides and Ground Water and the Hexazinone State Management Plan for Protection of Ground Water.

* Soil and Water Conservation Districts' technical assistance to farmers with BMPs to reduce NPS pollution.

* The cooperative relationship among Department of Environmental Protection, Land Use Regulation Commission, and Worcester Peat Co., the owner of the Denbo Heath Peat Mine.

Proposed Actions for Enhanced Protection:

* Develop and implement Total Water Use Management Plans for each watershed with the goal of meeting the needs of both Atlantic salmon and agricultural production.

* Develop a watershed specific Non-point Source program for the Sheepscot River.

* Target ICM education programs and promote use of BMPs to further reduce potential threats from pesticide use and non-point source pollution.

* Identify for protection wetlands with functions that are important for maintaining the integrity of Atlantic salmon habitat.

* Enhance the Board of Pesticide Control programs that evaluate and mitigate the threats to Atlantic salmon associated with pesticide use.

* Improve the permit review process and standards for erosion control for Peat Mines.

* Evaluate the threat to Atlantic salmon from water quality changes associated with Peat Mining.

These new actions, implemented through cooperative efforts of watershed steering committees, in conjunction with existing programs, laws, and regulations, will protect Atlantic salmon habitat quantity and quality.

B. Aquacultural Activities

Status of Aquaculture

Atlantic salmon aquaculture in Maine has grown from a production of about 1,000,000 pounds in 1988 to over 22,000,000 pounds in 1995. Rapid expansion of the industry occurred during the period 1987-1991, but growth has moderated significantly in recent years. More than 90 percent of the sea cage culture occurs within 30 miles of the Maine-Canadian border. Development of new lease sites is down from 18 in 1989 to only eight sites during the 1990s, while numbers of cages per lease site has increased from an average of 21 cages to 30. The current Maine industry has consolidated into 14 companies, down from 18 in 1989, which operate 27 sea cage sites on 840 acres of leased water, six freshwater smolt-rearing facilities on four rivers and five fish processing plants. Maine producers annually stock 3-3.5 million smolts in sea cages in eastern Maine. The principal stocks used in the Maine aquaculture industry include Penobscot, St. John and Landcatch strains, the first two of which are North American strains and the latter a European. Public and private freshwater salmon culture facilities are located in the Sheepscot, East Machias and Pleasant River watersheds. The Maine industry accounts for only 1/3 of the total number of Atlantic salmon annually stocked in sea cages adjacent to the five eastern Maine salmon rivers (Dennys, Machias, East Machias, Pleasant and Narraguagus). New Brunswick growers stock 6-7 million St. John strain smolts annually in the adjacent Canadian waters of Passamaquoddy Bay. The state has no control over regulation of activities at the Canadian sites.

Potential Threats to Atlantic Salmon and Its Habitat

Potential threats to salmon may occur if farmed salmon transmit diseases or parasites to Atlantic salmon stocks within the seven rivers or within the nearshore marine environment when wild salmon migrate through marine waters adjacent to sea cages; if farmed salmon escapees interbreed with wild salmon and cause reduced fitness for survival; if farmed salmon superimpose redds on wild salmon redds, thus disrupting the egg incubation process; or if farmed salmon escape as juveniles into the salmon rivers and compete for food and space with wild stocks. Extensive monitoring programs have been established for all Maine hatchery and aquaculture sites to minimize even the potential indirect impacts on the wild salmon.

Potential threats from any poor husbandry practiced in freshwater fish culture operations could affect wild salmon in the Sheepscot, Pleasant and East Machias River populations. Potential threats from sea cage rearing operations would likely impact Atlantic salmon populations in the Dennys, East Machias, Machias, Pleasant and Narraguagus Rivers. All these potential threats are associated with indirect impacts on salmon. There is no directed take of salmon associated with aquaculture activities, nor is there any documented impact on salmon habitat associated with public or commercial aquaculture.

Current Actions Addressing Threats:

Disease transmission

* Maintain the current state, federal and New England fish health inspection protocols to assure the highest quality of fish health of fish stocks used in the aquaculture industry.

* Continue to vaccinate farmed fish prior to stocking in sea cages to minimize the risk of contracting endemic diseases in the nearshore marine environment.

* Private insurance standards enforced.

* Interbreeding, Redd Superimposition and Competition for Freshwater Habitat.

In order to minimize the potential threats of interbreeding, redd superimposition and competition for freshwater habitat, the aquaculture industry currently employs the following measures:

* All farmed salmon, except for commercial brood stock, are harvested before the onset of maturation, thereby minimizing the likelihood of survival of immature escapees to maturity when redd superimposition and interbreeding could occur.

* Escape control efforts include minimizing the impact of storms through careful site selection, regular equipment maintenance and storm preparation procedures involving gear inspections and securing/relocating drift-prone equipment.

* Seal induced escapes are minimized through the use of predator guard nets, and acoustic and visual deterrent devices.

* Freshwater culture facilities screen water intake and discharge sources to minimize escape of juvenile salmon into the wild.

Proposed Actions for Enhanced Protection

Disease transmission

* The aquaculture industry will continue to work with the Department of Marine Resources, Department of Inland Fisheries & Wildlife, Department of Agriculture Food and Rural Resources, U.S. Department of Agriculture, U.S. Fish and Wildlife Service and National Marine Fisheries Service to maintain and improve the current state and federal fish health protocols as they relate to salmonid fish culture through the newly established state/federal/industry Fish Health Advisory Board.

* Disease risk to wild salmon will be further limited by the development of an emergency disease eradication program involving action steps to be taken in the event of the detection of exotic fish pathogens in public or private rearing facilities.

* An ongoing epidemiological monitoring program will be expanded to determine the type, incidence and geographic distribution of salmonid pathogens in Maine.

* Industry husbandry practices will be documented, evaluated, and compiled into a Fish Health Code of Practices by University of Maine veterinarians in cooperation with the Maine Aquaculture Association.

* Complete adoption of industry Code of Practices to minimize escapes of farmed fish.

Interbreeding, Redd Superimposition and Competition for Freshwater Habitat

* Accidental escapes of farmed salmon will be minimized by the industry developing and adopting a Fish Culture Code of Practices for culture of salmon in freshwater and at sea cage sites.

* Certain wild salmon stocks will be increased by rearing river-specific stocks to maturity in sea cages and releasing adults or progeny back into rivers of origin. This will both aid in restoration by increasing the number of wild salmon, thus reducing the potential impact of farmed salmon escapees on genetic variability of wild salmon through interbreeding.

* Weirs will be constructed on certain salmon rivers (Dennys, Machias, East Machias, Pleasant) to aid in research and management and to cull out aquaculture escapees.

* A marking system proposal will be developed cooperatively with the industry that would compliment the effectiveness of weirs by enabling farmed salmon to be more easily distinguished from wild salmon. Any marking system must: (a) be universal including Canada; (b) be cost-effective for the industry; (c) not reduce the market value of the fish and (d) not increase the incidence of disease.

* Initiate research into seal behavior around sea cages and site and cage vulnerability to seal attack. The results of this research will be used to evaluate the need for seeking reauthorization of limited lethal take of seals at farm sites.

C. Forest Management Activities

Status of Forestry

Forestry is the dominant land use in the five eastern river watersheds. By comparison, limited forestry is conducted in the Sheepscot and, to a lesser extent, in the Ducktrap watersheds. Like all forests in Maine, these areas have been providing wood products for over 200 years. Some stands are on their fourth cycle of cutting and regeneration.

Champion International Corporation is the largest landowner within the five eastern river watersheds, owning approximately 433,000 acres. Its largest holdings are in the Narraguagus, Machias, Dennys, and East Machias watersheds. Georgia Pacific Corporation is a major landowner in the Dennys and East Machias watersheds. Each manages its forest resources primarily for the harvesting and production of pulp for paper manufacturing and other wood products. Lands are also managed for wildlife and public recreation. Their two principal land use activities are timber harvesting and road building. Smaller wood lot owners also harvest timber within the Sheepscot and Ducktrap River watersheds. On each of the seven Atlantic salmon rivers, timber harvesting between 1990 and 1994 occurred on between 2 percent and 10 percent of the land in the watershed. The relatively low acreage cut on the Dennys, Machias, East Machias, Pleasant, and Narraguagus Rivers was in part due to extensive spruce budworm salvage operations in the 1980s that produced a regenerating forest.

Potential Threats to Atlantic Salmon and Its Habitat

The U.S. Fish and Wildlife Service and the National Marine Fisheries Service concluded in their report, *Status Review for Anadromous Atlantic Salmon in the United Stated* (January 1995) and in the Federal Register (60 Fed. Reg. 50532 (September 29, 1995)), that "while historic forest practices have had harmful effects on Atlantic salmon in certain watersheds, numerous state and federal laws now exist to prevent or significantly reduce adverse impacts to Atlantic salmon and other aquatic species." Many of the historic threats to Atlantic salmon habitat listed below are addressed by current regulations and programs. Moreover, the forestry related actions proposed in the Conservation Plan build upon present regulations and initiatives, providing incremental improvement to existing Atlantic salmon protection. Without these regulatory controls, forest practices have the potential to affect Atlantic salmon habitat in the seven river watersheds by producing non-point source pollution, altering stream temperatures and hydrology, directly disturbing habitat, blocking fish passage with poorly designed road crossings, or depositing woody debris in streams.

Current actions addressing threats

Maine's laws are supplemented by a number of important volunteer protection initiatives. State agencies and private organizations promote a variety of protection measures aimed at protecting water quality and enhancing Atlantic salmon habitat. They are:

* Project SHARE, a private non-profit organization dedicated to conserving and enhancing Atlantic salmon habitat;

* Sustainable Forestry initiative, a forestry industry effort to promote a wide range of values in forest management decisions;

* Riparian Management Zones, Champion International's self imposed, restrictive management standards for timber operations near streams and rivers;

* Maine Non-point Source Management Program, an inter agency program promoting the use of

best management practices in Maine's forests;

* Code Enforcement Training and local shoreland zoning technical assistance, a program designed to help municipalities effectively administer shoreland zoning standards;

* Sheepscot Valley Conservation Association, an organization dedicated to improving and maintaining Sheepscot River waters; and

* Ducktrap River Coalition, a coalition of organizations promoting protection of the Ducktrap River watershed.

<u>*Proposed Actions for Enhanced Protection*</u>

* **Control non-point source pollution**. Implement BMPs. Forestry best management practices will continue to be an effective means of managing non-point-source pollution. State agencies, municipalities, industry and local volunteers will coordinate efforts to raise compliance with prescribed best management practices through education and enforcement.

* **Protect important habitat through landowner agreements**. State agencies and landowners will use the latest habitat information prepared by the Atlantic Salmon Authority to develop agreements for allowable activities in and around important Atlantic salmon habitat. Fish biologists and landowners will design activities and locations of projects to protect salmon habitat. When appropriate, landowners, state agencies, and private conservation groups will use conservation easements to permanently protect important habitat. In the event that appropriate cooperative agreements between landowners and state agencies cannot be reached, the Land and Water Resources Council will evaluate the use of additional state and municipal regulations to protect significant habitat.

* **Maintain shade, stream temperatures**. State agencies, volunteer organizations and landowners will work with logging contractors and resource managers to raise awareness about the importance of maintaining windfirm, riparian shade trees. State agencies will increase enforcement and monitoring of harvesting activities near streams.

* **Monitor pesticide use.** The Department of Environmental Protection the Board of Pesticide Control, and the Atlantic Salmon Authority will review the geographic usage of pesticides in the seven watersheds and DEP will target areas for in-stream assessment. The Board of Pesticide Control will work cooperatively with the Cooperative Extension Service and Department of Agriculture Food and Rural Resources to update pesticide best management practices based on the latest research and promote these practices in the seven river watersheds. The Board of Pesticide Control will adjust state pesticide regulations to eliminate any significant risks to Atlantic salmon.

D. Recreational Fishing Activities

<u>*Status of Angling Activities*</u>

The Atlantic Salmon Authority determines regulations for Atlantic salmon angling in inland and coastal waters. Anglers must purchase an Atlantic salmon license to legally fish for Atlantic salmon in inland and designated coastal waters and fly fishing is the only legal way to fish. The remainder of coastal waters is open to general angling. A catch-and-release Atlantic salmon season is open from May 1 to September 15. Lower sections of the Dennys, East Machias, Machias, Pleasant, Narraguagus, Ducktrap, and Sheepscot Rivers are open through October 15. There are sections of some of these rivers that have a shorter season or are closed to angling. The catch-and-release regulation states that Atlantic salmon must be ?immediately released and returned alive, without further injury to the water from which it was taken.@ Residents (including Native American citizens of Maine), non-residents, applied for 6584 Atlantic salmon licenses in 1982 but only 1481 licenses in 1995. Historic annual rod catches for Atlantic salmon for the seven rivers have been as high as 500 fish; current rod catch is estimated at fewer than 100 fish due to greatly depressed runs.

The Department of Inland Fisheries and Wildlife uses lake and river specific seasons, minimum lengths, and possession limits to manage cold and warm water fisheries. A freshwater fishing license is required and there are two inland fishing seasons; from April 1 through either September 30, October 31, or November 31; and from ice-in through March 31. During the open water period, early season trout angling gives way to bass and pickerel fishing on most of the seven rivers. Angling for both cold and warm water species is popular throughout much of the year on headwater lakes and ponds. The Department of Marine Resources requires no license, and fishing is open year-round for most estuarine and marine sport fishes.

Potential Threats to Atlantic Salmon and Its Habitat

Until recently, the greatest threat to Atlantic salmon was legal harvest through directed fishing, but harvest is no longer allowed. Poaching is a continuing problem and may increase as runs increase. Although mortality can occur from directed catch-and-release angling, new data suggest that a carefully regulated catch-and-release fishery will have little impact on the species.

Existing sport fisheries regulations for most freshwater, estuarine, and marine fishes are sufficient to protect Atlantic salmon. The number of Atlantic salmon killed each year as a result of recreational fishing for other freshwater and estuarine species is estimated to be very small. Juvenile salmon may be harvested if misidentified as brook trout, brown trout, or rainbow trout. An overwintering adult Atlantic salmon could be taken in an estuary or during winter as a trophy landlocked Atlantic salmon or brown trout. This Plan proposes additional steps to further minimize, if not eliminate, the risk of an accidental by-catch.

Current Actions Addressing Threats

* No directed harvest of Atlantic salmon, catch-and-release angling only.

* Enforcement of Atlantic Salmon Authority, Department of Inland Fisheries and Wildlife, and Department of Marine Resources recreational fishing regulations.

Proposed Actions For Enhanced Protection

* Modify catch-and-release program for Atlantic salmon to further restrict dates, location and gear allowed.

* Institute a reporting and monitoring program to better estimate any incidental take.

* In the mainstem and major tributaries of all seven rivers; from July to September 30, artificial lures only, minimum length on all trout, 8 inches.

* Within the Sheepscot River and estuary, make the maximum length for brown trout and landlocked salmon 25 inches.

* Within all Washington County waters, except West and East Grand Lakes, make maximum length 25 inches for landlocked salmon.

* On the Dennys River and Cathance Stream eliminate size and bag restriction on black bass.

* Where necessary, close cold water adult Atlantic salmon holding areas to all fishing.

* Increase law enforcement with the addition of two seasonal wardens.

* Propose increased penalties for Atlantic salmon poaching.

E. Other Natural and Human Related Threats

Potential Threats to Atlantic Salmon and Its Habitat

Commercial harvest of suckers, eels, elvers and alewives could impact Atlantic salmon, but current data indicate that there is no problem except, perhaps, a small by-catch of juvenile salmon (parr or smolts) in the elver fishery. There is also the potential of interbreeding among wild Atlantic salmon, land locked salmon, brown trout and salmon escaping from inland hatcheries. In addition, several fish species (e.g., splake and brown trout) managed by DIF&W could prey on juvenile Atlantic salmon. A further area of concern is the magnitude of predation by cormorants on migrating smolts and predation by seals on returning adult salmon. Beaver also impact salmon by blocking migration routes and flooding salmon habitat. Populations of cormorants, seals and beaver have expanded greatly in the past 15 years.

Residential development and gravel mining operations have the potential to degrade Atlantic salmon habitat. On the Ducktrap and Sheepscot River watersheds, increasing second home development, associated road building, and gravel mining in shoreland areas, if left unchecked, may accelerate sedimentation of important streams and tributaries, increase stream temperatures, and compromise water quality. The Coopers Mills dam on the Sheepscot River may be restricting fish passage and thereby reducing available habitat.

Currently, comprehensive toxic pollution data do not exist for the seven rivers. Through its Surface Water Ambient Toxic Monitoring Program, the Department of Environmental Protection (DEP) has sampled fish tissue from the Dennys River related to the Smith Junk Yard and Eastern Surplus Superfund Site. Additionally, they have biomonitored marcoinvertebtate communities on the Sheepscot River. DEP may collect additional data over the next three years to measure changes to macroinvertibrate populations and fish behavior. Early indications are that the seven rivers contain low levels of historic toxic pollutants, consistent with the non-industrial history of these rivers.

Current Actions Addressing Threats

* Monitor by-catch of commercial fisheries.
* Moratorium on new eel weirs.
* Stricter regulation of elver fisheries.
* Enforcement of commercial fishing regulations.
* Breach beaver dams in fall.
* Expand beaver trapping season.
* Enforcement of Municipal Shoreland Zoning restrictions.
* Municipal Comprehensive Plans and local ordinances designed to steer development away from sensitive resources and manage the effects of gravel mining and development.
* Ongoing Surface Water Ambient Toxic Monitoring Program at DEP.
* Evaluation of Superfund Site. Contaminant samples taken and initial clean-up completed.
* Toxic removal action at Smith Junk Yard.

Proposed Actions For Enhanced Protection

* Recommend exclusion panels on elver nets.
* Enact a moratorium on commercial sucker harvesting in freshwater on the seven rivers.

* Continue to monitor by-catch.

* Monitor populations of other salmonids that might interbreed with Atlantic salmon.

* Screen the outlet of Meddybemps Lake to prevent the drop down of landlocked salmon during spawning season.

* Screen outflows of hatcheries to prevent escapement of small salmon and trout.

* Evaluate the impact of splake and brown trout predation on Atlantic salmon and adjust stocking where appropriate.

* Initiate a study to evaluate the impact of cormorant predation on wild smolts.

* Initiate a study of seal predation on returning adult salmon.

* Encourage expanded beaver trapping, targeting important habitat.

* Use existing river conservation organizations to help establish the goals of individual River Steering Committees.

* Develop agreements with individual landowners on protection of specific habitat.

* Encourage conservation easements or acquisition of prime habitat and adjoining lands.

* Identify and rectify fish passage problems at the Coopers Mill dam.

* Assist the Surface Water Ambient Toxic Monitoring Program to examine Downeast rivers.

* Detailed evaluation of Superfund Site with contaminant samples, including soils and fish.

* Coordinate fisheries issues into clean-up planning for Superfund Site.

* Analyze contaminant samples taken at Smith Junk Yard, summer 1996.

* Moratorium on disposing of toxic materials at Smith Junk Yard.

V. Additional Actions Proposed to Restore Atlantic Salmon and Its Habitat

A. Education and Enforcement Programs

The purpose of the Education and Outreach Program is to ensure that the general public and other targeted groups are informed and supportive of the programs to conserve Atlantic salmon, and to provide meaningful opportunities for these same groups to become actively involved in and contribute to salmon conservation efforts on the seven affected Maine rivers. The rationale behind this stated purpose is that healthy rivers and Atlantic salmon populations yield broad ecological, cultural, and economic benefits to the general public (not just specific user groups, such as anglers), and that the overall success of specific conservation programs proposed in this Conservation Plan will depend in part on the additional resources represented within the private sector.

The Education and Outreach Program will address recreational fisheries, forestry, agricultural, and aquaculture issues. Target audiences and participants include the general public, user groups, resource management groups, and municipalities. Education and outreach efforts will be designed to inform and "train" practitioners with respect to modified or improved techniques (e.g. best management practices) that will yield a net conservation benefit for Atlantic salmon. In addition, education and outreach programs will specifically address training non-technical volunteers to provide general assistance in Atlantic salmon assessment, enhancement, enforcement, and monitoring activities. Education and outreach programs will be developed in coordination with state agencies and municipalities to enhance enforcement and compliance activities within each watershed. Specific attention will be given to involving local municipalities especially through enhanced contact with state agencies in developing BMPs and in delivering technical assistance materials (Table 2 - Currently not available for viewing).

Table 2. Education and outreach efforts designed to yield a net conservation benefit for Atlantic salmon

The Education and Outreach Program will include:

1. **Conservation Plan Summary**

Use to educate general audiences about the contents of the Conservation Plan.

2. **Atlantic Salmon Education Center**

Target general public, school children, recreational anglers, outdoor recreationists. Specific information about salmon biology, life history, habitat requirements, threats, and remedies to threats; also ecological and economic benefits of healthy salmon populations.

3. **Local Training and Assistance**

Establish within each watershed council a program that targets local anglers and other interested citizens, who will be trained in specific areas of assessment, enhancement, monitoring and compliance. Result will be a trained volunteer network throughout watersheds to assist under-funded and under-staffed federal and state agencies implement conservation programs for salmon.

4. **Catch-and-Release Educational Campaign**

Catch-and-release angling, when properly conducted, can result in extremely low or zero mortality for angled fish. The campaign will detail specific methods to maximize survival of angled salmon, and provide the rationale behind the need for strict compliance.

5. **Best Management Practices Technical Assistance Materials**

Develop and disseminate ongoing programs to educate land managers and natural resource users about the importance of Atlantic salmon, land- and water-based threats to salmon survival, and best management practices to mitigate/eliminate threats.

6. **Professional Training**

Provide training and materials to appropriate state agency staff (e.g. DEP, LURC, DOT) on Atlantic salmon life history, habitat needs, and sensitivity to a variety of issues (i.e. peat mining, water withdrawal, dam construction, oil spill cleanup, pesticide registration, highway reconstruction planning). Ongoing training will reinforce protection through existing regulatory and planning processes and during emergencies.

B. Enforcement

State agencies currently have adequate personnel to enforce the existing regulatory activities referenced in this Conservation Plan. For example, the Land Use Regulation Commission (LURC) currently licenses pump sites and water withdrawal in unorganized towns while Department of Environmental Protection (DEP) deals with sites under the Natural Resource Protection Act. DEP also licenses all discharges into waters of the state. Both Department of Agriculture Food and Rural Resources (DAFRR) and DEP enforce non-point source pollution associated with agricultural activities, while LURC or DEP oversee the development of peat mining. The major issue in forestry is oversight of shoreland timber harvesting. Maine Forest Service (MFS), DEP and LURC are involved in monitoring and enforcement of this activity.

All siting, developing and operation of finfish aquaculture facilities within the state come under the jurisdiction of Department of Marine Resources (DMR). Both

DMR and Department of Inland Fisheries and Wildlife (DIF&W) enforce fish health regulations.

Regulation of recreational fishing is done primarily by DIF&W with DMR regulating fishing in tidal waters. There is a need to add two seasonal wardens Downeast to enforce the proposed salmon regulations. Special training sessions will be held for DIF&W and DMR Wardens to increase their knowledge of the Conservation Plan and the enforcement issues. As appropriate, similar sessions will be held for enforcement personnel in other state agencies.

On each river, watershed conservation groups (Watershed Councils) will be organized to monitor state regulations and report potential violations of state laws to the appropriate authorities. They will be the "eyes and ears" for each river.

VI. Enhanced Restoration Efforts

A. River Specific Pen Rearing

In 1995 the Maine Aquaculture Industry offered its support for a marine pen-rearing effort of three river specific stocks to enhance the Conservation Plan. The Task Force, realizing that ocean survival was very low, accepted this offer to jump start the restoration effort. In the winter of 1996, 10,000 eggs each from the Dennys, Machias and Narraguagus Rivers were transferred to private hatcheries where they will be raised to smolts and a percentage then reared in marine pens to adulthood to be released into their natal rivers in 1999. The remaining smolts will be released directly into the rivers. The Aquaculture Industry has agreed to cover all rearing costs for this initial effort and has signed an initial agreement with the appropriate state and federal agencies. An ad hoc committee will develop a protocol for the release program and determine the costs and sources of funding for evaluation of the project. It is anticipated that this effort will be repeated for several years until adequate spawning numbers return from the ocean. The funding base will need to be expanded to support this effort.

B. Local River Watershed Councils

The proportion and distribution of different land uses within the Sheepscot, Ducktrap, Narraguagus, Pleasant, Machias, East Machias, and Dennys watersheds determine many of the potential threats and opportunities for conservation and restoration of Atlantic salmon. The key to creatively and successfully providing for the needs of Atlantic salmon and agriculture, aquaculture, forestry, and fisheries resources is watershed planning. The proposed Conservation Plan uses watershed specific councils, which include all interested stakeholders, to cooperatively guide Atlantic salmon conservation activities related to land use and other activities within each watershed. These councils will have representatives from state and federal agencies, conservation groups, industries, towns, landowners and other interested groups or individuals. The river watershed councils will coordinate their efforts with those of local groups having similar goals such as the Ducktrap River Coalition and the Sheepscot Valley Conservation Association. The councils will continue to review the status of threats in each watershed and determine the need for continued or new efforts to further minimize any potential threat to Atlantic salmon from future activities present in the watershed.

The process ensures that all stakeholders in the watersheds have the opportunity to participate in decisions concerning conservation actions. This creative and cooperative effort by state and federal agencies and private interests is a key element of the Conservation Plan. The Sheepscot River Watershed Council was organized in the spring of 1996 and is currently addressing agricultural non-point-source pollution within that watershed.

Other organizations currently active within the seven watersheds will participate in the councils. The Ducktrap Coalition is working on a variety of conservation issues within that watershed. The MidCoast Atlantic Salmon Watershed Council was established to coordinate planning on the Ducktrap and Sheepscot Rivers. A recent grant will enable them to continue resource mapping and develop conservation priorities. Project SHARE has coordinated conservation efforts on five Downeast rivers since 1994. Local angler groups are present on all the rivers and are active in salmon conservation.

C. Project SHARE (Salmon Habitat And River Enhancement)

Formed in mid-1994, Project SHARE is a voluntary association of landowners, businesses, government officials, researchers, educators, and conservation organizations committed to conserve and enhance Atlantic salmon habitat and populations in the Downeast region of Maine. Project SHARE is participating in a series of projects aimed at understanding and improving Atlantic salmon habitat and restoration. Among the projects directly related to forestry activities are a water temperature monitoring study, habitat mapping, and the promotion of training sessions for foresters and landowners on Atlantic salmon biology and habitat. Other projects have included installing a weir on the Dennys River, locating and removing several river blockages caused by log and debris buildup, working to complete construction of the Pleasant River Hatchery and Education Center, and repairing a fish ladder and water control gate at Meddybemps dam on the Dennys River. Project SHARE will likely play a key role in implementing many of the strategies called for in the state's Conservation Plan.

VII. River Specific Conservation Actions

The tables (Section B) outlining potential threats, actions to minimize those threats and promote recovery with along with timetables for implementation on each river.

VIII. Monitoring Implementation

The Conservation Plan represents a concentrated, collaborative effort by the State of Maine and numerous organizations, businesses and citizens to provide optimal conditions for the successful propagation of wild Atlantic salmon in seven rivers. The overall goal of this monitoring schedule is to set up and sustain a system by which individuals may gauge progress on the completion of the Plan's distinct tasks and to measure the progress toward achievement of the Conservation Plan's goal.

A Coordinator will oversee the monitoring of the Conservation Plan during the five year implementation schedule as articulated in the Plan. No single agency or organization has the capacity to initiate and sustain an ongoing conservation and recovery evaluation program. As with the Plan's development, many individuals will collaborate on measuring the Plan's progress.

A key component of this monitoring schedule will be the flexibility to adapt fisheries management and/or habitat protection actions to changing conditions found in the field. As the Coordinator collects and analyzes field information, situations are likely to arise that require adjustments to the Conservation Plan. The Coordinator will use the monitoring reports to highlight issues and areas that may need direction and resolution from the Land & Water Resources Council and the Atlantic Salmon Authority. The Land & Water Resources Council, in consultation with the Atlantic Salmon Authority, will direct state agencies' actions and be responsible for overall monitoring of the Conservation Plan's implementation.

The Land & Water Resources Council, with staff support from the Coordinator, will annually summarize the Conservation Plan activities and results for each river watershed. To do so the Council will rely upon the Atlantic Salmon Authority, various state agencies, and watershed councils to provide information it will use to construct its river monitoring report. The Council will submit annual reports to the National Marine Fisheries Service and U.S. Fish & Wildlife Service.

The Coordinator will focus on four basic areas for monitoring and reporting purposes: HABITAT PROTECTION, HABITAT ENHANCEMENT, SPECIES PROTECTION, AND FISHERY MANAGEMENT. All the Conservation Plan activities fall into one of these four broad categories.

The basis for evaluating the Conservation Plan's progress are a series of goals and benchmarks under each of the broad categories. These goals and benchmarks are drawn from the river-specific conservation actions in the Conservation Plan itself and the underlying work of the Atlantic Salmon Conservation Task Force's technical working groups. The following schedule (Section C) outlines the major goals for the plan, includes specific strategies for achieving the goals, provides measurement criteria, and outlines benchmarks and outcomes. The Land and Water Resources Council and the Coordinator will use these goals and benchmarks to guide the development of the monitoring reports.

IX. Funding the Conservation Plan

Funding sources for the Conservation Plan are varied and represent a mixture of federal, state and private entities. Currently both the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS) support ongoing work on the seven Downeast rivers. Applications for their ongoing support have been submitted to continue habitat assessment, population monitoring, estuarine and marine survival studies, as well as specific requests for weirs, evaluation of seal predation, public outreach, and fish marking protocols.

State agencies will re-direct current staff and resources to components of the Conservation Plan that come under their jurisdiction. This is fully compatible with current State operations, as personnel in each affected department are already charged with these responsibilities and can integrate Plan priorities into ongoing operations. For example, DIF&W will make appropriate changes to fishing regulations, evaluate impacts of competitors/predators and increase enforcement activities. DMR will also increase enforcement activities, evaluate impact of any commercial fisheries on Atlantic salmon and coordinate oversight of aquaculture activities as they might affect Atlantic salmon. Maine Department of Transportation will monitor all road and bridge construction as they might influence Atlantic salmon habitat. MFS, LURC, DEP, and the Board of Pesticide Control will participate in watershed steering committees and provide oversight for activities influencing Atlantic salmon and their habitat, such as riparian zone management, point and non-point source pollution, water extraction, and pesticides. Thus, hundreds of thousands of dollars in current funding to support existing state programs will be directed toward these priorities.

The Natural Resources Conservation Service, along with state agency personnel, is undertaking a total water management plan for several rivers with the goal of developing the best alternatives for irrigation. Soil and Water Conservation Districts, as well as the Natural Resources Conservation Service and state agencies, will implement best management practices and non-point source technical assistance programs where appropriate. This initiative has been funded by the Natural Resources Conservation Service from existing operations funding. The new federal Wildlife Habitat Incentive Program (WHIP) and Environmental Quality Incentives Program (EQUIP) will provide additional funds to support activities on the seven rivers.

Several corporate sponsors have agreed to help fund the project. The aquaculture industry is committed to fully funding the initial river-specific pen rearing program and will support additional years of the effort. Project SHARE has been extensively backed by Champion and Georgia Pacific Corporations and has undertaken weir construction, education and training, as well as several research efforts. Their commitment will continue. The Maine Blueberry growers will facilitate watershed councils, monitor BMPs and contribute to specific projects.

Much of the education and outreach and development of river specific steering committees will be supported by grants from nonprofit organizations. To that extent, the National Fish & Wildlife Foundation has already contributed to SHARE and the MidCoast Atlantic Salmon Watershed Council. The State and the Atlantic Salmon Federation are currently seeking grants from a variety of private foundations to support local watershed conservation organizations. A coalition of private and governmental organizations have submitted grant requests to the National Fish & Wildlife Foundation and the Maine Outdoor Heritage Fund to support habitat enhancement, further education, help establish local watershed conservation organizations, and increase law enforcement.

B. River Specific Conservation Actions

Table 1. Sheepscot River and Watershed

Activity Potential Threat to Atlantic Salmon and Its Habitat	Action to Reduce Threat and Promote Recovery	Action Priority	Action Feasibility	Responsible Entities, lead in CAPS	Implementation Date	Cost - Existing, New, Annual with estimates of new funding
Conservation	Adopt watershed management approach and monitor progress	High	High	LWRC	Done	N/E $20,000 all rivers
	Establish a watershed council	High	High	LWRC	1997	E
Agricultural Practices Agricultural practices have the potential to cause non-point source pollution, thereby affecting habitat quality.	Target Sheepscot River for a land use oriented, water- shed specific non-point source program.	High	High	DAFRR, dep, watershed council	Ongoing	E. $10,000
	Seek funding to develop, coord- inate and implement a watershed specific non- point source program	High	High	DAFRR, watershed council, dep, spo	Ongoing	E
	Survey non- point source program effect- iveness with substrate embeddedness survey and Atlantic salmon population assessments.	Moderate	High	ASA	1997 - 1998	N to be determined
	Implement non- point source and best manage- ment practices technical assist- ance programs to enable farmers to adopt appropriate practices and monitor effectiveness.	High	High	SWCD/nrcs, umce, dafrr	1997 - 1998	N $20,000/2 years
Agricultural Practices Improper biosolids use can cause non-point source pollution.	Enforce DEP siting and land spreading standards and have ASA review permit applications.	High	High	DEP, asa	Ongoing	E
Pesticide Use Target Crops	Target best management practices educational programs and promote use of best manage- ment practices for Christmas trees and corn.	Low	High	UMCE, bpc, swcd, nrcs	Ongoing	E
	Identify wetlands with water quality benefits to					

Agricultural Practices Wetlands alterations may affect functions important to habitat and water quality	Atlantic salmon.	Moderate	High	WC, DEP	Ongoing	E
Oil, Fuel + Contaminant Mgt. If spilled into habitat these products may be toxic to Atlantic salmon.	Maintain programs for handling oil, fuel, pesticides and other potential contaminates. Respond to all accidental spills.	Low	High	DEP/bpc	Ongoing	E
Aquaculture. Transmission of disease pathogens via Atlantic salmopn eggs importation/transfer to freshwater fish culture facilities on the seven salmon rivers.	Require all importations/transfers of eggs to meet State of Maine, New England Salmonid Health, Title 50 CFR and/or Canadian FHPR requirements.	Low	Low	DMR, if&w	Ongoing	E
Aquaculture. Escape of Atlantic salmon juveniles from freshwater hatcheries on salmon rivers would allow aquaculture salmon to compete with wild salmon in riverine environment or transmit diseases to wild salmon.	Maintain conventional fish screening & containment systems to prevent escape of juvenile salmon from fish culture facilities. Use protected groundwater supplies or filtration/water treatment systems that prevent introduction of pathogens from the wild that would be magnified in a hatchery environment & passed back into the river via hatchery discharges.	High	High	AQUACULTURE INDUSTRY, if&w	Ongoing	E
Forestry. % of watershed in a regenerating forest condition effects water flow dynamics that may alter available habitat	Assess the potential for abnormal flow in the watersheds using remote sensing and model hydrology dynamics and present finding to local watershed councils	High	High	MFS, landowners	1998, 1999	N/E $20,000 (cost applys to all seven rivers)
Land managers and developers may unwittingly disturb important Atlantic salmon habitat through various land use activities including forest practices	The Atlantic Salmon Authority completes its habitat mapping and assessment work	High	High	ASA	1997	N. $45,192 (costs apply to 7 rivers; work is complete on several rivers)
	The State Planning Office, Atlantic Salmon Authority, and the Maine Department of Inland Fisheries and Wildlife will cooperatively work with landowners to develop Memoranda of Agreement (MOA) and conservation easements for the protection of all important Atlantic salmon habitat.	High	Medium	SPO, asa, if&w, landowners, wc	1997-2001	E. $40,000 (costs apply to 7 rivers)

	In the absence of compre- hensive landowner MOAs or conservation easements, the Land & Water Resources Council will evaluate the designation of "significant Atlantic salmon habitat"	High	Medium	LWRC	1999	E
	DEP, working with land- owners and the watershed council, will encourage municipalities to place "significant Atlantic salmon habitat" in a Resource Protection zone.	high	low	DEP, spo, asa	1999	E. $7,000 (costs apply to 7 rivers)
Forestry. Skid trails, road construction, maintenance, & placement may cause secondary impacts that affect salmon such as: ❶ sedimentation which may clog spawning beds & hinder alevin emergence; ❷ poor culvert installation which blocks fish passage; and ❸ increased access which may create greater fishing pressure	ì&❷ State agencies will work with the Sheepscot Valley Conservation Association and watershed council to design and implement an ongoing program to educate road building and logging contractors and landowners on the importance of Atlantic salmon habitat and to promote the use of forestry best management practices. î Resource agencies working with Sheepscot Valley Conservation Association, watershed council, landowners, and others will cooperatively monitor key access points and control access where necessary.	Medium Medium	High Low	MFS, dep, spo, watershed council, svca, landowners WC, svca, if&w, angling groups, landowners	1997 and beyond 1997 and beyond	N $25,000 (costs apply to 7 rivers) N $10,000 (costs apply to 7 rivers)
Forestry. Increased temperatures and algal blooms from excessive shade removal along streams can adversely affect Atlantic salmon survival by changing their feeding, reproductive, and migratory behavior, reducing suitable rearing habitat and available cold water refugia , and eliminating macroinvertebrate habitat	Increased enforcement and compliance monitoring of shoreland harvesting Educate logging contractors and resource managers to be sensitive to shading needs when planning tree harvesting in shoreland areas.	Medium high	High high	DEP, if&w, mfs, and wc SVCA/mfs,astf	1996 and beyond 1998 - 2000	E. $20,000 (costs apply to 7 rivers) E. $9,000 (costs apply to 7 rivers)
Forestry. Excessive woody debris blocking fish passage, restricting stream flow, and reducing dissolved oxygen	Remove blockages with advice from fisheries biologists	Low	High	SVCA, wc, if&w	ongoing	E

General Pesticide Use. Pesticide use has the potential to threaten Atlantic salmon if pesticides are present at levels that cause acute or chronic effects. Toxicity varies with chemicals.	DEP, ASA, & BPC will review will review the geographic usage of pesticides in the seven watersheds and DEP will target areas for in-stream assessment.	Medium	High	DEP, bpc, asa	1998 - 2000	E $15,000
	The Board of Pesticide Control will work cooperatively with state agencies and the University of Maine Co-operative Extension Service to update best management practices based on the latest research and promote the use of these practices within the seven river watersheds.	Low	High	BPC, state agencies, univ. of Maine	1997 and beyond	E
	The Board of Pesticide Control will respond to evidence of pesticides causing adverse environmental effects by proposing amendments to its regulations, updating best management practices, and changing product registration status where appropriate.	Low	High	BPC	1997 ongoing	E
Recreation. Incidental take associated with ATS angling	Severely limit catch and release fishery: restrictions on time (May 1-June 15, Sept. 15-Oct. 15), location (provide an upriver sanctuary for salmon), and gear (no nets, barbless hooks).	High	High	ASA	1997, 1998	E. $3500 (costs apply to 7 rivers)
Recreation. Taking of juvenile Atlantic salmon by trout anglers who misidentify the species. Hooking mortality of juvenile Atlantic salmpon caught incidentally by trout and landlocked slamon anglers	Change fishing regulations in seven rivers and major tributaries (7/1-8/15) to: ALO minimum length on trout 8"; keep bag limit at 5; 7/1-9/30 current regulations but minimum length on trout is 8".	High	High	IF&W	1998	E
Recreational Angling. Adult Atlantic salmon are suseptable to angling in cold water holding areas.	Monitor cold water holding areas and close to all fishing as necessary.	High	High	IF&W	1997, 1998	E
Commercial Fishing. Potential for incidental taking	IF&W will not permit this activity in any locations having the potential to catch an Atlantic salmon.	Low	High	IF&W	Ongoing	E

of ATS adults and juveniles in fyke and/or trap nets used by private citizens in early spring to capture common suckers for lobster bait in ATS rivers and their tributaries						
Commercial Fishing. Potential for incidental taking of smolts and adult Atlantic salmon in elver fyke nets.	Monitoring of the fishery for Atlantic salmon by-catch will be ongoing. Require exclusion panels in fyke nets.	Low	High	DMR/asa	1997	E
Recreation. Hooking mortality of Atlantic salmon caught incidentally by anglers fishing for pickerel or bass.	The ALO regulation from 7/1-9/30 will minimize hooking mortality of any Atlantic salmon that may be hooked by pickerel and bass anglers	Low	High	IF&W	1998	E
Recreation. Taking of Atlantic salmon kelts in lower Sheepscot River upper estuary and calling it a large adult brown trout or landlocked salmon.	Promulgate new regulation establishing a 25" maximum size on landlocked salmon and brown trout in the Sheepscot River and estuary.	Low	High	IF&W/dmr	1998	A $3,500 total for all rule changes (costs apply to 7 rivers)
Illegal Fishing. Poaching of adult salmon	Staff all warden districts in the 7 drainage and hire 2 seasonal wardens. Assign top priority to prevention of poaching for wardens in districts where poaching is likely.	High	Medium	IF&W/asa, dmr	1997	N $20,120/year (cost applies to 7 rivers)
Illegal Fishing	Increase penalties for poaching	Medium	High	IF&W	1997	E
Predation. Adverse effects of harbor seals on adult Atlantic salmon at mouth of river.	Study impacts of seals on Atlantic salmon.	High	High	DMR/maic	1997, 1998	to be determined
	Pursue control of seal populatons if warranted.	High	Low	DMR/maic		to be determined

Predation. Predation on Atlantic salmon smolts by double-crested cormorants.	Study impacts of cormorants on wild Atlantic salmon smolts.	High	High	IF&W/dmr,usfwn, nmfs, Universities	1998	N $50,000 over 2 years (cost applies to 7 rivers)
	Pursue control of commarant populations if warranted.	High	Medium	IF&W/dmr,usfwn, nmfs, Universities		to be determined
Predation. Predation on juvenile Atlantic salmon by American eels inhabiting Atlantic salmon nursery habitat	Sample gut contents of American eels captured which electrofishing juvenile salmon habitat to determine food habitats.	Currently unknown	High	ASA, if&w, university	1997 - 1998	E
Wildlife Interactions. Populations of beavers in the 7 drainages have been increasing leading to serious limitations of Atlantic salmon ability to access upstream spawning areas as well as some degradation of Atlantic salmon habitat through impoundments and subsequent stream warming/siltation	Systematically remove key beaver dams with the assistance of Atlantic salmon and wildlife biologists.	High	High	WC, asa, if&w, svca	Ongoing	N. $3,000 (costs apply to 7 rivers)

Entity Abbreviations:

ASA - Atlantic Salmon Authority, Maine
ASTF - Atlantic Salmon Task Force (Governor's), Maine
BPC - Board of Pesticide Control, Maine
CES - Cooperative Extension Service
DAFRR - Dept of Agriculture Food and Rural Resources, Maine
DEP - Department of Environmental Protection, Maine
DMR - Department of Marine Resources, Maine
SVCA - Sheepscot Valley Conservation Association
LWRC - Land & Water Resources Council, State Planning Office
IF&W - Inland Fish and Wildlife, Maine
LURC - Land Use Regulatory Commission, Maine
MAIS- Maine Aquaculture Inovation Center
MFS - Maine Forest Service
NRCS - Natural Resources Conservation Service, Federal
NMFS - National Marine Fisheries Service
SHARE - Salmon Habitat and River Enhancement, Project
SWCD - Soil and Water Conservation District, local
USFWS - United States Fish and Wildlife Service, Federal
WC - Watershed Council

Table 2. Ducktrap River and Watershed

Activity Potential Threat to Atlantic Salmon and Its Habitat	Action to Reduce Threat and Promote Recovery	Action Priority	Action Feasibility	Responsible Entities, lead in CAPS	Implementation Date	Cost - Existing, New, Annual with estimates of new funding
Conservation	Adopt watershed management approach and monitor progress	High	High	LWRC	Done	E
	Establish a watershed council	High	High	LWRC	1997	N/E $20,000 all rivers
Agricultural Practices Wetlands alterations may affect functions important to habitat and water quality	Continue education and compliance with current wetlands regulations	Low	High	WC, DEP	ongoing	E
Oil, Fuel + Contaminant Mgt. If spilled into habitat these products may be toxic to Atlantic salmon.	Maintain programs for handling oil, fuel, pesticides and other potential contaminates. Respond to all accidental spills	Low	High	DEP, bpc	ongoing	E
Forestry. % of watershed in a regenerating forest condition effects water flow dynamics that may alter available habitat	Assess the potential for abnormal flow in the watersheds using remote sensing and model hydrology dynamics and present finding to local watershed councils	High	High	MFS, landowners	1998, 1999	N/E $20,000 (costs apply to 7 rivers)
Land Uses. Land managers and developers may unwittingly disturb important Atlantic salmon habitat through various land use activities including forest management	The Atlantic Salmon Authority completes its habitat mapping and assessment work	High	High	ASA	1997	N. $45,192 (costs apply to 7 rivers; work is complete on several rivers)
Land Uses. Land managers and developers may unwittingly disturb important Atlantic salmon	The State Planning Office, Atlantic Salmon Authority, and the Maine Department of Inland Fisheries and Wildlife will cooperatively work with landowners to develop Memoranda of Agreement (MOA) and conservation easements for the protection of all important Atlantic salmon habitat.	High	Medium	SPO, asa, if&w, landowners, ducktrap river coalition, wc	1997-2001	E. $40,000 (costs apply to 7 rivers)

unwittingly disturb important Atlantic salmon habitat through various land use activities including forest management (Continued)	In the absence of comprehensive landowner MOAs or conservation easements, the Land & Water Resources Council will evaluate the designation of "significant Atlantic salmon habitat"	High	low	ASA, ducktrap river coalition	1997	E
	DEP, working with landowners and the watershed council, will encourage municipalities to place "significant Atlantic salmon habitat" in a Resource Protection zone.	High	Medium	DEP/spo, asa	1999	E. $7,000 (costs apply to 7 rivers)
Forestry. Skid trails, road construction, maintenance, & placement may cause secondary impacts that affect salmon such as: ❶ sedimentation which may clog spawning beds & hinder alevin emergence; ❷ poor culvert installation which blocks fish passage; and ❸ increased access which may create greater fishing pressure	ì&❷ State agencies will work with the Ducktrap River Coalition to design and implement an ongoing program to educate road building and logging contractors and landowners on the importance of Atlantic salmon habitat and to promote the use of forestry best management practices. î Resource agencies working with the Ducktrap River Coalition, watershed council, landowners, and others will cooperatively monitor key access points and control access where necessary.	Medium Medium	High Low	MFS/dep, spo, dcr ÐWC, ducktrap river coalition, if&w, angling groups, landowners	1997 and beyond 1997 and beyond	ì&❷ N $25,000 (costs apply to 7 rivers) î N $10,000 (costs apply to 7 rivers)
Forestry. Increased temperatures and algal blooms from excessive shade removal along streams can adversely affect Atlantic salmon survival by changing their feeding, reproductive, and migratory behavior, reducing suitable rearing habitat and available cold water refugia , and eliminating macroinvertebrate habitat	Increased enforcement and compliance monitoring of shoreland harvesting Educate logging contractors and resource managers to be sensitive to shading needs when planning tree harvesting in shoreland areas.	Medium High	High High	DEP, if&w, mfs, dcr DUCKTRAP RIVER COALITION, mfs	1996 and beyond 1996 and beyond	E. $20,000 (costs apply to 7 rivers) E. $9,000 (costs apply to 7 rivers)
Forestry. Excessive woody debris blocking fish passage, restricting stream flow, and reducing dissolved oxygen	Remove blockages with advice from fisheries biologists	Low	High	DUCKTRAP RIVER COALITION, wc	ongoing	E

General Pesticide Use. Pesticide use has the potential to threaten Atlantic salmon if pesticides are present at levels that cause acute or chronic effects. Toxicity varies with chemicals.	DEP, ASA, & BPC will review will review the geographic usage of pesticides in the seven watersheds and DEP will target areas for in-stream assessment.	Medium	High	DEP, bpc, asa,	1998 - 2000	E $15,000
	The Board of Pesticide Control will work cooperatively with state agencies and the University of Maine Co-operative Extension Service to update best management practices based on the latest research and promote the use of these practices within the seven river watersheds.	Low	High	BPC, state agencies, univ. of Maine	1997 and beyond	E
	The Board of Pesticide Control will respond to evidence of pesticides causing adverse environmental effects by proposing amendments to its regulations, updating best management practices, and changing product registration status where appropriate.	Low	Low	BPC	1997 ongoing	E
Recreational Angling. Incidental take associated with ATS angling	Severely limit catch and release fishery: restrictions on time (May 1-June 15, Sept. 15-Oct. 15), location (provide an upriver sanctuary for salmon), and gear (no nets, barbless hooks).	High	High	ASA	1997, 1998	E $3500 (costs apply to 7 rivers)
Recreational Angling. Taking of juvenile Atlantic salmon by trout anglers who misidentify the species. Hooking mortality of juvenile Atlantic salmon caught incidentally by brook trout, landlocked salmon, and brown trout anglers.	Change fishing regulations in seven rivers and major tributaries (7/1-8/15) to: ALO minimum length on trout 8"; keep bag limit at 5; 7/1-9/30 current regulations but minimum length on trout is 8".	High	High	IF&W	1998	E
Recreational Angling. Adult Atlantic salmon are suseptable to angling in cold water holding areas.	Monitor cold water holding areas and close to all fishing as necessary.	High	High	IF&W	1997, 1998	E
Recreational Angling. Hooking mortality of Atlantic salmon caught incidentally by anglers fishing for PKL or bass.	The ALO regulation will minimize hooking mortality of any Atlantic salmon that may be hooked by pickerel and bass anglers	Low	High	IF&W	1998	E
Illegal Fishing. Poaching of adult salmon	Staff all warden districts in the 7 drainages and	High	Medium	IF&W/asa, dmr	1997	N. $20,120

	hire 2 seasonal wardens. Assign top priority to prevention of poaching for wardens in districts poaching is likely.					/year (cost applies to 7 rivers)
Illegal Fishing	Increase penalties for poaching	Medium	High	IF&W	1997	E
Commercial Fishing. Potential for incidental taking of Atlantic salmon adults and juveniles in fyke and/or trap nets used by private citizens in early spring to capture common suckers for lobster bait in Atlantic salmon rivers and their tributaries	IF&W will not permit this activity in any locations having the potential to catch an Atlantic salmon.	Low	High	IF&W	Ongoing	E
Commercial Fishing. Potential for incidental taking of smolts and adult Atlantic salmon in elver fyke nets.	Monitoring of the fishery for Atlantic salmon by-catch will be ongoing. Require exclusion panels.	Low	High	DMR/asa	1997	E
Predation. Adverse effects of harbor seals on adult Atlantic salmon at mouth of river.	Study impacts of seals on Atlantic salmon.	High	High	DMR/maic	1997	to be determined
	Pursue control of seal populatons if warranted.	High	Low	DMR/maic		to be determined
Predation. Predation on Atlantic salmon smolts by double-crested cormorants.	Study impacts of cormorants on wild Atlantic salmon smolts.	High	Low	IF&W, dmr,usfwn, nmfs, Universities	1997	N $50,000 over 2 years (cost applies to 7 rivers)
	Pursue control of commarant populations if warranted.	High	Medium	IF&W, dmr,usfwn, nmfs, Universities		to be determined
Wildlife Interactions. Populations of beavers in the 7 drainages have been increasing leading to serious limitations of Atlantic salmon ability to access upstream spawning areas as well as some degradation of Atlantic salmon habitat through impoundments and subsequent stream warming/siltation	Systematically remove key beaver dams with the assistance of Atlantic salmon and wildlife biologists.	High	High	WC, ASA, IF&W	Ongoing	E $3,000 (cost applies to 7 rivers)
Predation. Predation on juvenile Atlantic salmon	Sample gut contents of American eels captured which electrofishing juvenile salmon habitat to	Currently unknown	High	ASA, IF&W, university	1997 - 1998	E

by American eels inhabiting Atlantic salmon nursery habitat	determine food habitats.					

Entity Abbreviations:

ASA - Atlantic Salmon Authority, Maine
ASTF - Atlantic Salmon Task Force (Governor's), Maine
BPC - Board of Pesticide Control, Maine
CES - Cooperative Extension Service
DAFRR - Dept of Agriculture Food and Rural Resources, Maine
DEP - Department of Environmental Protection, Maine
DMR - Department of Marine Resources, Maine
SVCA - Sheepscot Valley Conservation Association
LWRC - Land & Water Resources Council, State Planning Office
IF&W - Inland Fish and Wildlife, Maine
LURC - Land Use Regulatory Commission, Maine
MAIS- Maine Aquaculture Inovation Center
MFS - Maine Forest Service
NRCS - Natural Resources Conservation Service, Federal
NMFS - National Marine Fisheries Service
SHARE - Salmon Habitat and River Enhancement, Project
SWCD - Soil and Water Conservation District, local
USFWS - United States Fish and Wildlife Service, Federal
WC - Watershed Council

Table 3. Narraguagus River and Watershed

Activity Potential Threat to Atlantic Salmon and Its Habitat	Action to Reduce Threat and Promote Recovery	Action Priority	Action Feasibility	Responsible Entities, lead in CAPS	Implementation Date	Cost - Existing, New, Annual with estimates of new funding
Conservation	Adopt watershed management approach and monitor progress	High	High	LWRC	1997	E
	Establish a watershed council	High	High	LWRC	1997	N/E $20,000 all rivers
Water Use. Agricultural water use has the potential to reduce habitat area and quality of residual habitat, especially in dry summers.	Adopt water use management approach	High	High	NRCS, wc, asa, dafrr, dep, if&w, lurc, usfws, Project SHARE	1997	E
	Develop best alternatives from Water Use Management Plan	Medium	High	NRCS, wc, asa, dep, dafrr, dep, if&w, lurc, usfws	1998	E $200,000 $300,000
	Seek funding to implement Water Use Management Plan	Medium	to be determined	LWRC, dafrr	1998 - 2002	N to be determined
Water Use. Temperature of direct discharges has the potential to affect habitat quality.	Define thermal plume associated with direct discharges	Medium	High	DEP, asa	1997	E
Pesticide Use Target Crops	Target integrated crop management educational programs and promote use of best management practices on blueberries and cranberries	Medium	High	UMCE, bpc, swcd, nrcs	ongoing	E A $3,000
Hexazinone Use	Implement Hexazinone State Management Plan for the Protection of Groundwater and monitor effectiveness of best management practices	Medium	High	BPC, umce, growers	ongoing	E A $1,000

Hexazinone Use. Low levels of pesticides may have physiological or behavioral effects.	Determine if hexazinone has chronic effects on Atlantic salmon	Medium	High	ASA, usfws	1999	N $ 30,000
Agricultural Practices Agricultural practices have the potential to cause nonpoint source pollution, thereby affecting habitat quality.	Implement non-point source and technical assistance programs to assist growers in adopting applicable practices (best management practices) and monitor effectiveness.	Low	High	SWCD, nrcs, umce, dafrr	1997 - 1998	N $20,000 /2 years
Direct Discharges Processing plants not meeting discharge standards could affect habitat by lowering water quality.	Continue compliance monitoring and reporting to DEP	Low	High	PROCESSORS	ongoing	E
Agricultural Practices Improper biosolids use can cause non-point source pollution.	Maintain DEP siting standards and have ASA review permit applications	Low	High	DEP, asa	ongoing	E
Agricultural Practices Wetlands alterations may affect functions important to habitat and water quality.	Develop inventory of moderate and high value wetlands in watershed.	Low	High	WC, dep, lurc	ongoing	E
Oil, Fuel + Contaminant Mgt. If spilled into habitat these products may be toxic to Atlantic salmon.	Maintain programs for handling oil, fuel, pesticides and other potential contaminates. Respond to all accidental spills	Low	High	DEP, bpc	ongoing	E
Peat Mining Peat mine discharges have the potential to affect habitat quality.	Continue water quality and compliance monitoring	High	High	DEP, Worcester Peat Co.	ongoing	E

	Improve permit review and required standards	Medium	High	DEP, lurc, asa	ongoing	E
Water quality changes below peat mines may affect Atlantic salmon.	Estimate threat from water quality changes	High	High	ASA, IF&W, usfws	ongoing	E

Aquaculture. Escaped Atlantic salmon of aquaculture origin pose risks of: genetic interchange with wild Atlantic salmon, superimposition of redds over those of wild salmon, & competition between river-specific & farmed fish offspring	Maintain and operate existing weir to enumerate wild runs & selectively remove farmed salmon to prevent interactions.	High	High	ASA, usfws, nmfs, Project SHARE	1997	E
	River specific stock rehabilitation (rear river-specific stocks in sea cages & release adults or progeny back into parent streams).	High	High	MAIC, Aquaculture Industry, asa, Project SHARE	Ongoing	N. Per river: Rear /Mark/Stock: $61,000 Coordinate/Evaluate: $100,000
	Seal Damage Control • Maintain efforts to reduce seal access to primary containment nets on sea cages through use of double bottoms, predator curtains and/or acoustic deterrents, as needed, particularly in winter; continue regular removal of mortalities from cage bottoms • Include seal attack prevention in Loss Control Code of Practice • Research behavior of seal populations and individuals in vicinity of sea cages; research site and cage design characteristics for vulnerability to seal attack; improve attack incidence and loss documentation within industry	High	Medium	DMR, maic, nmfs	1998	N. Seal behavior study: $250,000 Selective Seal removal (experimental) $100,000 Selective Seal removal (industry wide): $300,000
	Escape Prevention • Maintain efforts to limit the impact of storms and winter sea conditions through careful site selection, regular equipment maintenance, storm preparation and gear inspection and post-storm gear inspection and repair • Develop and adopt industry-driven Loss Control Code of Practice to refine and transfer most effective husbandry practices through the industry	High	High	DMR, maic	1997	N. Develop Code: management practices: $10,000. Annual Compliance Inspections: $3,000 (costs apply to 7 rivers)

Aquaculture. Escaped Atlantic salmon of aquaculture origin pose risks of: genetic interchange with wild Atlantic salmon, superimposition of redds over those of wild salmon, & competition between river-specific & farmed fish offspring (CONTINUED)	Universal Marking • Research efficient, cost effective and market-acceptable means of marking farm reared salmon at an existing handling point in the production process, to aid, in conjunction with weirs, easier identification and removal of farm origin strays that enter salmon rivers • Convene joint Maine/US/Canadian workshop to harmonize marking policy when appropriate means becomes available	Medium	Low	DMR, NMFS, MAIC, asa, aquaculture industry	1997, 1998	N. $100,000 for all rivers N. US/Canada Workshop: $2,500 (costs apply to 7 rivers)
	Use of Sterile Fish for Aquaculture • Continue to monitor world research into biology and commercialization of triploid or other sterile salmon	Low	Low	DMR, maic, nmfs	Unknown	N/A
Aquaculture. Diseases in farmed salmon may be transmitted to wild Atlantic salmon	Fish Health • Maintain third-party inspection and certification of hatcheries; continue placement of certified, disease-free fish in sea cages; continue vaccination of smolt prior to placement; maintain health monitoring and intervention efforts at sea cage sites • Maintain state control over fish health standards and movement of fish into and around the state • Develop emergency disease eradication plan; expand the fish health monitoring project to include a full epidemiological study • Develop and adopt industry-driven Fish Health Code of Practice to refine and transfer most effective husbandry practices through the industry	High	High	DAFRR, dmr, if&w, aquaculture industry, maic	Ongoing	N. Full epid. monitoring program: $200,000 (costs apply to 7 rivers)
Aquaculture. Escape of aquaculture smolts during	Vaccinate smolts against naturally occurring pathogens in nearshore coastal environments.			DAFRR, dmr,		

transfer to sea cages or transmission of diseases from aquaculture smolts to coastal water adjacent to the seven salmon rivers.	Inspect smolts for fish health status prior to transfer. Deny transfer permit if inspection detects pathogens of significant concern to ATS. Include smolt transfer procedures in Loss Control Code of Practice.	Low	High	aquaculture industry	Ongoing	N/A
Aquaculture. Presence of farmed salmon in sea cages may become source of pathogens/parasites that could be passed onto wild salmon smolts or adults moving thru the area. Water quality reduction could occur from poor aquaculture practice.	Continue placement of vaccinated, certified, disease-free fish in sea cages; maintain health monitoring and intervention efforts at sea cage sites; develop and adopt industry-driven Fish Health Code of Practice to refine and transfer most effective husbandry practices through the industry. Continue DMR aquaculture lease monitoring programs to assure compliance w/water quality standards. Continue fish health inspection/vaccination/monitoring programs.	Medium	High	Aquaculture Industry, maic, dmr	Ongoing	N/A
Aquaculture. Loss of farmed salmon from sea cages could result in escapees entering salmon rivers and interacting with naturally-spawned populations.	Develop and adopt industry-driven Loss Control Code of Practice to refine and transfer most effective husbandry practices through the industry.	High	High	Aquaculture Industry, maic, dmr	1997	N/E. Develop Code: $10,000; Annual compliance inspections $3,000 (Costs apply to 7 rivers)
Aquaculture. Loss of farmed salmon during harvest of production fish could result in escapes entering salmon rivers & interacting w/ wild salmon.	Adopt best practical management practices when harvesting salmon. Salmon are harvested year ›round as market demand dictates. The potential impact would be greatest in the fall when handling sexually mature fish which could potentially escape. Harvest Items • Maintain loss control efforts to schedule harvests around sea and weather conditions that limit risk to crews and crop; continue container transport of live-harvest fish; continue anesthetization of sea-killed fish • Include harvest techniques in Loss Control Code of Practice	Low	High	AQUACULTURE INDUSTRY, maic, dmr	Ongoing	E
Aquaculture. Spawning of brood stock & egg procurement could lead to transmission of diseases acquired at cage sites to freshwater	All brood stock used to produce eggs are either lethally sampled or reproductive fluids sampled to test for pathogens. Paired matings & tracking of	High	High	Aquaculture, Industry, maic, dmr	Ongoing	E

rearing facilities via eggs. Diseased brood stock may infect wild salmon smolts or adults that pass thru the area in the vicinity of brood stock.	egg lots of known parentage allows eggs from infected parents to be discarded. All eggs are disinfected prior to movement to freshwater hatcheries in accordance w/prescribed fish health procedures. Brood stock are vaccinated to protect against disease in the wild.					
Forestry. % of watershed in a regenerating forest condition effects water flow dynamics that may alter available habitat	Assess the potential for abnormal flow in the watersheds using remote sensing and model hydrology dynamics and present finding to local watershed councils	High	High	MFS, landowners	1998, 1999	N/E $20,000 (cost applys to all seven rivers)

Land Uses. Land managers and developers may unwittingly disturb important Atlantic salmon habitat through various land use activities including forest management	The Atlantic Salmon Authority completes its habitat mapping and assessment work	High	High	ASA, usfws, Project SHARE	1997	N. $45,192 (costs apply to 7 rivers; work is complete on several rivers)
	The State Planning Office, Atlantic Salmon Authority, and the Maine Department of Inland Fisheries and Wildlife will cooperatively work with landowners to develop Memoranda of Agreement (MOA) and conservation easements for the protection of all important Atlantic salmon habitat.	High	Medium	SPO, asa, if&w, landowners, wc	1997-2001	E. $40,000 (costs apply to 7 rivers)
	In the absence of comprehensive landowner MOAs or conservation easements, the Land & Water Resources Council will evaluate the designation of "significant Atlantic salmon habitat"	High	Medium	LWRC	1999	E
	DEP, working with landowners and the watershed council, will encourage municipalities to place "significant Atlantic salmon habitat" in a Resource Protection zone.	High	Medium	DEP, spo, asa, Project SHARE	1997-1998	E. $7,000 (costs apply to 7 rivers)
	LURC, working with landowners, Project SHARE and watershed councils, will incorporate Atlantic salmon habitat mapping by rezoning these areas to a Fish and Wildlife Protection Subdistrict with standards for activities in the habitat zones.	High	High	LURC, asa, Project SHARE, wc	1998	E. $2500 (costs apply to 7 rivers)
Forestry. Skid trails, road construction, maintenance, & placement may cause secondary impacts that affect salmon such as: ❶ sedimentation which may clog spawning beds & hinder alevin emergence; ❷ poor culvert installation which blocks fish passage; and ❸ increased access which may create greater fishing pressure	ì&❷ State agencies will work with Project SHARE to design and implement an ongoing program to educate road building and logging contractors and landowners on the importance of Atlantic salmon habitat and to promote the use of forestry best management practices.	Medium	High	MFS, project SHARE, dep, lurc, spo, watershed council, landowners	1997 and beyond	ì&❷N/E. $25,000 (costs apply to 7 rivers)
	î Resource agencies working with Project SHARE, landowners, and others will cooperatively monitor key access points and control access where necessary and appropriate.	Medium	Low	WC, PROJECT SHARE, if&w, angling groups, landowners	1997	î N $10,000 (costs apply to 7 rivers)

Forestry. Increased temperatures and algal blooms from excessive shade removal along streams can adversely affect Atlantic salmon survival by changing their feeding, reproductive, and migratory behavior, reducing suitable rearing habitat and available cold water refugia , and eliminating macroinvertebrate habitat	Increased enforcement and compliance monitoring of shoreland harvesting	Medium	High	DEP, LURC, if&w, mfs, watershed council, Project SHARE, municipalities	1997 and beyond	E. $20,000 (costs apply to 7 rivers)
	Educate logging contractors and resource managers to be sensitive to shading needs when planning tree harvesting in shoreland areas.	High	High	PROJECT SHARE, mfs	1997 - 2000	N $5,000 (costs apply to 7 rivers)
Forestry. Excessive woody debris blocking fish passage, restricting stream flow, and reducing dissolved oxygen	Remove blockages with advice from fisheries biologists	Medium	High	PROJECT SHARE, wc, if&w, asa	ongoing	E
General Pesticide Use. Pesticide use has the potential to threaten Atlantic salmon if pesticides are present at levels that cause acute or chronic effects. Toxicity varies with chemicals.	DEP, ASA, & BPC will review will review the geographic usage of pesticides in the seven watersheds and DEP will target areas for in-stream assessment.	Medium	Low	DEP, bpc, asa	1998 - 2000	E
	The Board of Pesticide Control will work cooperatively with state agencies and the University of Maine Co-operative Extension Service to update best management practices based on the latest research and promote the use of these practices within the seven river watersheds.	Medium	High	BPC, state agencies, university	1997 and beyond	E
	The Board of Pesticide Control will respond to evidence of pesticides causing adverse environmental effects by proposing amendments to its regulations, updating best management practices, and changing product registration status where appropriate.	Medium	High	BPC	1997 ongoing	E
Recreational Angling. Incidental take associated with ATS angling	Severely limit catch and release fishery: restrictions on time (May 1-June 15, Sept. 15-Oct. 15), location (provide an upriver sanctuary for salmon), and gear (no nets, barbless hooks).	High	High	ASA	1997, 1998	E $3,500 (costs apply to 7 rivers)

Recreational Angling. Taking of juvenile Atlantic salmon by trout anglers who misidentify the species. Hooking mortality of juvenile Atlantic salmon caught incidentally by brook trout, landlocked salmon, and brown trout anglers.	Change fishing regulations in seven rivers and major tributaries (7/1-8/15) to: ALO minimum length on trout 8"; keep bag limit at 5; 7/1-9/30 current regulations but minimum length on trout is 8".	High	High	IF&W	1998	E
Recreational Angling. Potential of keeping an Atlantic salmon kelt taken in a lake by ice fishing as a "large trophy-sized landlocked salmon or brown trout@ resulting in the taking of an Atlantic salmon.	Promulgate new regulation establishing a 25" minimum size on landlocked salmon in all of Washington County, except West Grand and East Grand Lakes.	High	High	IF&W	1998 (will require emergency rule	E. $3,500 total for all rule changes (costs apply to 7 rivers)
Recreational Angling. Adult Atlantic salmon are suseptable to angling in cold water holding areas.	Monitor cold water holding areas and close to all fishing as necessary.	High	High	IF&W	1997 and beyond	E
Recreational Angling. Hooking mortality of Atlantic salmon caught incidentally by anglers fishing for chain pickerel or bass.	The ALO regulation will minimize hooking mortality of any salmon that may be hooked by pickerel and bass anglers	Low	High	IF&W	1998	E
Illegal Fishing	Increase penalties for poaching	Medium	High	IF&W	1997	E
Illegal Fishing. Poaching of adult salmon	Staff all warden districts in the 7 drainage and hire 2 seasonal wardens. Assign top priority to prevention of poaching for wardens in districts where poaching is likely.	High	Medium	IF&W, asa, dmr	1997	N $20,120/year (cost applies to 7 rivers)
Commercial Fishing. Potential for incidental taking of Atlantic salmon adults and juveniles in fyke and/or trap nets used by private citizens in early spring to capture common suckers for lobster bait in Atlantic salmon rivers and their tributaries	IF&W will not permit this activity in any locations having the potential to catch an Atlantic salmon.	Low	High	IF&W	Ongoing	E
Commercial Fishing. Potential for incidental taking of juvenile and adult Atlantic salmon in elver fyke nets.	Monitoring of the fishery for Atlantic salmon by-catch will be ongoing. Require exclusion panels.	Low	High	DMR, asa	1997	E
Predation and Competition. Depending on their size, splake can prey on or compete with Atlantic salmon..	Monitor splake movements to ensure that they are not taking up residence in Atlantic salmon habitat and identify Atriggers@ whereby splake stocking would be halted	Low	High	IF&W, asa	Ongoing	E. $500/year (costs apply to 7 rivers)

	would be halted.					
Predation and Competition. Depending on their size, brown trout can prey on or compete with Atlantic salmon.	Monitor brown trout movements to ensure that they are not taking up residence in Atlantic salmon habitat and identify Atriggers@ whereby brown trout stocking would be halted.	Low	High	IF&W, asa	Ongoing	E. $500/year (costs apply to 7 rivers)
Predation. Adverse effects of harbor seals on adult Atlantic salmon at mouth of rivers.	Study impacts of seals on Atlantic salmon.	High	High	DMR, maic	1997	to be determined
	Pursue control of seal populatons if warranted.	High	Low	DMR, maic		to be determined
Predation. Predation on Atlantic salmon smolts by double-crested cormorants.	Study impacts of cormorants on wild AT smolts.	High	High	IF&W, dmr,usfwn, nmfs, universities	1997	N $50,000 over 2 years (cost applies to 7 rivers)
	Pursue control of commarant populations if warranted.	High	Medium	IF&W, dmr,usfwn, nmfs, Universities		to be determined
Wildlife Interactions. Populations of beavers in the 7 drainages have been increasing leading to serious limitations of Atlantic salmon ability to access upstream spawning areas as well as some degradation of Atlantic salmon habitat through impoundments and subsequent stream warming/siltation	Systematically remove key beaver dams with the assistance of Atlantic salmon and wildlife biologists.	High	High	WC, if&w, Project SHARE	Ongoing	N. $3,000 (costs apply to 7 rivers)
Predation. Pickerel predation on smolts can reduce their numbers. The degree to which this occurs depends on the abundance of pickerel in areas smolts must migrate through en route to the ocean.	Promulgate new regulation on the mainstream of each Atlantic salmon river and on major salmon - producing tributaries: No bag limit on pickerel.	Medium	High	IF&W	1998	A. $3,500 total for all rule changes (costs apply to 7 rivers)
Predation. Predation on juvenile Atlantic salmon by American eels inhabiting Atlantic salmon nursery habitat	Sample gut contents of American eels captured which electrofishing juvenile salmon habitat to determine food habitats.	Currently unknown	High	ASA, if&w, university	1997, 1998	E.

Entity Abbreviations:

ASA - Atlantic Salmon Authority, Maine
ASTF - Atlantic Salmon Task Force (Governor's), Maine
BPC - Board of Pesticide Control, Maine
CES - Cooperative Extension Service
DAFRR - Dept of Agriculture Food and Rural Resources, Maine
DEP - Department of Environmental Protection, Maine
DMR - Department of Marine Resources, Maine
SVCA - Sheepscot Valley Conservation Association
LWRC - Land & Water Resources Council, State Planning Office
IF&W - Inland Fish and Wildlife, Maine
LURC - Land Use Regulatory Commission, Maine
MAIS- Maine Aquaculture Inovation Center
MFS - Maine Forest Service
NRCS - Natural Resources Conservation Service, Federal
NMFS - National Marine Fisheries Service
SHARE - Salmon Habitat and River Enhancement, Project
SWCD - Soil and Water Conservation District, local
USFWS - United States Fish and Wildlife Service, Federal
WC - Watershed Council

Table 4. Pleasant River and Watershed

Activity Potential Threat to Atlantic Salmon and Its Habitat	Action to Reduce Threat and Promote Recovery	Action Priority	Action Feasibility	Responsible Entities, lead in CAPS	Implementation Date	Cost - Existing, New, Annual with estimates of new funding
Conservation	Adopt watershed management approach and monitor progress	High	High	LWRC	1997	E
	Establish a watershed council	High	High	LWRC	1997	N/E $20,000 all rivers
Water Use Agricultural water use has the potential to reduce habitat area and quality of residual habitat, especially in dry summers.	Adopt water use management plan approach	High	High	NRCS, wc, asa, dafrr, dep, if&w, lurc, usfws, Project SHARE	1997	E
	Develop best alternatives from Water Use Management Plan	High	High	NRCS, watershed council, asa, dep, dafrr, dep, industry, if&w, lurc, usfws	1998	E $200,000 $300,000
	Seek funds to implement Water Use Management Plan	High	to be determined	LWRC, dafrr	1998 - 2002	N to be determined
	Voluntary reduction of water withdrawal in areas of highly valued salmon habitat	High	High	INDUSTRY, asa	1997 and beyond	E
	Review proposals for new cranberry bog and irrigation impoundment	High	High	DEP, lurc, asa, if&w	ongoing	E
	Reestablish USGS gauging station	High	High	USGS, asa	1997	N to be determined
Pesticide Use Target Crops	Target Integrated pest management educational programs and promote use of best management practices on blueberries and cranberries	Medium	High	UMCE, bpc, swcd, nrcs	ongoing	E A

	practices on blueberries and cranberries					$3,000
Hexazinone Use	Implement Hexazinone State Management Plan for the Protection of Groundwater and monitor effectiveness of best management practices	Medium	High	BPC, growers	ongoing	E A$1,000
Hexazinone Use. Low levels of pesticides may have physiological or behavioral effects.	Determine if hexazinone has chronic effects on Atlantic salmon	Medium	High	ASA, usfws	1999	N
Agricultural Practices Agricultural practices have the potential to cause non-point source pollution, thereby affecting habitat quality.	Implement non-point source pollution and technical assistance programs to assist growers in adopting applicable practices (best management practices) and monitor effectiveness.	Low	High	SWCD, nrcs, umce, dafrr	1997 - 1998	N $20,000 /2 years
Agricultural Practices Improper biosolids use can cause non-point source pollution.	Maintain DEP siting standards and have ASA review permit applications	Low	High	DEP, asa	ongoing	E
Wetlands Alteration Wetlands alterations may affect functions important to habitat and water quality.	Develop inventory of moderate and high value wetlands in watershed.	Low	High	WC, dep, lurc	ongoing	E
Oil, Fuel + Contaminant Mgt. If spilled into habitat these products may be toxic to Atlantic salmon.	Maintain programs for handling oil, fuel, pesticides and other potential contaminates. Respond to all accidental spills	Low	High	DEP, bpc	ongoing	E

Aquaculture. Escaped Atlantic salmon of aquaculture origin pose risks of: genetic interchange with wild Atlantic salmon, superimposition of redds over those of wild salmon, & competition between river-specific & farmed fish offspring.	Construct weirs on salmon rivers to enumerate wild runs & selectively remove farmed salmon to prevent interactions.	High	High	ASA, usfws, nmfs, project SHARE	1999	N. $267,000 for construction $10,000 for operation and maintenance
	River specific stock rehabilitation (rear river-specific stocks in sea cages & release adults to progeny back into parent streams)	High	High	MAIC, AQUACULTURE INDUSTRY, ASA, Project SHARE	Ongoing	N. Per river: Rear /Mark/Stock: $61,000 Coordinate/Evaluate: $100,000
	Seal Damage Control • Maintain efforts to reduce seal access to primary containment nets on sea cages through use of double bottoms, predator curtains and/or acoustic deterrents, as needed, particularly in winter; continue regular removal of mortalities from cage bottoms • Include seal attack prevention in Loss Control Code of Practice • Research behavior of seal populations and individuals in vicinity of sea cages; research site and cage design characteristics for vulnerability to seal attack; improve attack incidence and loss documentation within industry	High	Medium	DMR, maic, nmfs	1998	N. Seal behavior study: $250,000 Selective Seal removal (experimental) $100,000 Selective Seal removal (industry wide): $300,000
	Escape Prevention • Maintain efforts to limit the impact of storms and winter sea conditions through careful site selection, regular equipment maintenance, storm preparation and gear inspection and post-storm gear inspection and repair • Develop and adopt industry-driven Loss Control Code of Practice to refine and transfer most effective husbandry practices through the industry	High	High	DMR, maic	1997	N. Develop best management practices: $10,000 Annual Compliance Inspections: $3,000 (costs apply to 7 rivers)

Aquaculture. Escaped Atlantic salmon of aquaculture origin pose risks of: genetic interchange with wild Atlantic salmon, superimposition of redds over those of wild salmon, & competition between river-specific & farmed fish offspring. (CONTINUED)	Universal Marking • Research efficient, cost effective and market-acceptable means of marking farm reared salmon at an existing handling point in the production process, to aid, in conjunction with weirs, easier identification and removal of farm origin strays that enter salmon rivers • Convene joint Maine/US/Canadian workshop to harmonize marking policy when appropriate means becomes available	Medium	Low	DMR, NMFS, MAIC, asa, industry	1997, 1998	N. $100,000 for all rivers N. US/Canada Workshop: $2,500 (costs apply to 7 rivers)
	Use of Sterile Fish for Aquaculture • Continue to monitor world research into biology and commercialization of triploid or other sterile salmon	Low	Low	DMR, maic	Unknown	N/A
Aquaculture. Diseases in farmed fish may be transmitted to wild Atlantic salmon.	Fish Health • Maintain third-party inspection and certification of hatcheries; continue placement of certified, disease-free fish in sea cages; continue vaccination of smolt prior to placement; maintain health monitoring and intervention efforts at sea cage sites • Maintain state control over fish health standards and movement of fish into and around the state • Develop emergency disease eradication plan; expand the fish health monitoring project to include a full epidemiological study • Develop and adopt industry-driven Fish Health Code of Practice to refine and transfer most effective husbandry practices through the industry	High	High	DAFRR, dmr, if&w, aquaculture industry, maic	ongoing	N. Full epid. monitoring program: $200,000 (costs apply to 7 rivers)
Aquaculture. Escape of aquaculture smolts during	Vaccinate smolts against naturally occurring					

transfer to sea cages of transmission of diseases from aquaculture smolts to coastal water adjacent to seven salmon rivers.	pathogens in nearshore coastal environments. Inspect smolts for fish health status prior to transfer. Deny transfer permit if inspection detects pathogens of significant concern to Atlantic salmon. Include smolt transfer procedures in Loss Control Code of Practice.	Low	High	DAFRR, dmr, aquaculture industry	Ongoing	N/A
Aquaculture. Presence of farmed salmon in sea cages may become source of pathogens/parasites that could be passed onto Awild@ salmon smolts or adults moving thru the area. Water quality reduction could occur from poor aquaculture practice.	Continue placement of vaccinated, certified, disease-free fish in sea cages; maintain health monitoring and intervention efforts at sea cage sites; develop and adopt industry-driven Fish Health Code of Practice to refine and transfer most effective husbandry practices through the industry. Continue DMR aquaculture lease monitoring programs to assure compliance w/water quality standards. Continue fish health inspection/vaccination/monitoring programs.	Medium	High	Aquaculture Industry, maic, dmr	Ongoing	E
Aquaculture. Loss of farmed salmon from sea cages results in escapees entering salmon rivers and interacting with naturally-spawned populations.	Develop and adopt industry-driven Loss Control Code of Practice to refine and transfer most effective husbandry practices through the industry.	High	High	Aquaculture Industry, maic, dmr	1998	N/E. Develop Code: $10,000; Annual compliance inspections $3,000 (Costs apply to 7 rivers)
Aquaculture. Loss of farmed salmon during harvest of production fish could result in escapes entering salmon rivers & interacting with wild salmon	Adopt best practical management practices when harvesting salmon. Salmon are harvested year ›round as market demand dictates. The potential impact would be greatest in the fall when handling sexually mature fish which could potentially escape. Harvest Items • Maintain loss control efforts to schedule harvests around sea and weather conditions that limit risk to crews and crop; continue container transport of live-harvest fish; continue anesthetization of sea-killed fish • Include harvest techniques in Loss Control Code of Practice	Low	High	Aquaculture Industry, maic, dmr	Ongoing	N/A
Aquaculture. Spawning of brood stock & egg procurements could lead to transmission of diseases acquired at cage sites to freshwater rearing facilities via eggs. Diseased brood stock	All brood stock used to produce eggs are either lethally sampled or reproductive fluids sampled to test for pathogens. Paired matings & tracking of egg lots of known parentage allows eggs from	High	High	Aquaculture Industry, maic, dmr	Ongoing	E

may infect wild salmon smolts or adults that pass thru the area in the vicinity of brood stock.	infected parents to be discarded. All eggs are disinfected prior to movement to freshwater hatcheries in accordance w/prescribed fish health procedures. Brood stock are vaccinated to protect against disease in the wild.					
Forestry. % of watershed in a regenerating forest condition effects water flow dynamics that may alter available habitat	Assess the potential for abnormal flow in the watersheds using remote sensing and model hydrology dynamics and present finding to local watershed councils	High	High	MFS, landowners	1998, 1999	N/E $20,000 (cost applys to all seven rivers)

Land Uses. Land managers and developers may unwittingly disturb important Atlantic salmon habitat through various land use activities including forest management.	The Atlantic Salmon Authority completes its habitat mapping and assessment work.	High	High	ASA, usfws, Project SHARE	1997	N $45,192 (costs apply to 7 rivers; work complete on several rivers)
	The State Planning Office, Atlantic Salmon Authority, and the Maine Department of Inland Fisheries and Wildlife will cooperatively work with landowners to develop Memoranda of Agreement (MOA) and conservation easements for the protection of all important Atlantic salmon habitat.	High	Medium	SPO, asa, if&w, landowners, wc	1997-2001	E. $40,000 (costs apply to 7 rivers)
	In the absence of comprehensive landowner MOAs or conservation easements, the Land & Water Resources Council will evaluate the designation of "significant Atlantic salmon habitat"	High	Medium	LWRC	1999	E
	DEP, working with landowners and the watershed council, will encourage municipalities to place "significant Atlantic salmon habitat" in a Resource Protection zone.	High	Medium	DEP, spo, asa, Project SHARE	1997-1998	E $7,000 (costs apply to 7 rivers)
	LURC, working with landowners, Project SHARE and watershed councils, will incorporate Atlantic salmon habitat mapping by rezoning these areas to a Fish and Wildlife Protection Subdistrict with standards for activities in the habitat zones.	High	High	LURC, asa, Project SHARE, wc	1998	E $2500 (costs apply to 7 rivers)
Forestry. Skid trails, road construction, maintenance, & placement may cause secondary impacts that affect salmon such as: ❶ sedimentation which may clog spawning beds & hinder alevin emergence; í poor culvert installation which blocks fish passage; and î increased access which may create greater fishing pressure	ì&í State agencies will work with Project SHARE to design and implement an ongoing program to educate road building and logging contractors and landowners on the importance of Atlantic salmon habitat and to promote the use of forestry best management practices.	Medium	High	MFS, project SHARE, dep, lurc, spo, watershed council, landowners	1997 and beyond	ì&❷N/E. $25,000 (costs apply to 7 rivers)
	î Resource agencies working with Project SHARE, landowners, and others will cooperatively monitor key access points and control access where necessary and appropriate.	Medium	Low	WC, PROJECT SHARE, if&w, angling groups, landowners	1997	î N $10,000 (costs apply to 7 rivers)

Forestry. Increased temperatures and algal blooms from excessive shade removal along streams can adversely affect Atlantic salmon survival by changing their feeding, reproductive, and migratory behavior, reducing suitable rearing habitat and available cold water refugia , and eliminating macroinvertebrate habitat	Increased enforcement and compliance monitoring of shoreland harvesting	Medium	High	DEP/LURC, if&w, mfs, watershed council, Project SHARE, municipalities	1997 and beyond	E $20,000 (costs apply to 7 rivers)
	Educate logging contractors and resource managers to be sensitive to shading needs when planning tree harvesting in shoreland areas.	High	High	PROJECT SHARE, mfs	1997 - 2000	N. $5,000 (costs apply to 7 rivers)
Forestry. Excessive woody debris blocking fish passage, restricting stream flow, and reducing dissolved oxygen	Remove blockages with advice from fisheries biologists	Medium	High	PROJECT SHARE, watershed council, if&w, asa	ongoing	E
General Pesticide Use. Pesticide use has the potential to threaten Atlantic salmon if pesticides are present at levels that cause acute or chronic effects. Toxicity varies with chemicals.	DEP, ASA, & BPC will review will review the geographic usage of pesticides in the seven watersheds and DEP will target areas for in-stream assessment.	Medium	High	DEP, bpc, asa	1998 - 2000	E
	The Board of Pesticide Control will work cooperatively with the Department of Agriculture, Food & Rural Resources and other state agencies and the Cooperative Extension Service to update best management practices based on the latest research and promote the use of these practices within the seven river watersheds.	Medium	High	BPC, state agencies, university	1997 and beyond	E
	The Board of Pesticide Control will respond to evidence of pesticides causing adverse environmental effects by proposing amendments to its regulations, updating best management practices, and changing product registration status where appropriate.	Medium	High	BPC	1997 and beyond	E
Recreational Angling. Taking of juvenile Atlantic salmon by trout anglers who misidentify the	Change fishing regulations in seven rivers and major tributaries (7/1-8/15) to: ALO minimum	High	High	IF&W	1998	E

species. Hooking mortality of juvenile Atlantic salmon caught incidentally by brook trout, landlocked salmon, and brown trout anglers.	length on trout 8"; keep bag limit at 5; 7/1-9/30 current regulations but minimum length on trout is 8".					
Recreational Angling. Adult Atlantic salmon are suseptable to angling in cold water holding areas.	Monitor cold water holding areas and close to all fishing as necessary.	High	High	IF&W	1997 and beyond	E
Recreational Angling. Potential of keeping an Atlantic salmon kelt taken in a lake by ice fishing as a "large trophy-sized landlocked salmon or brown trout" resulting in the taking of an Atlantic salmon.	Promulgate new regulation establishing a 25" maximum size on landlocked salmon in all of Washington County, except East Grand and West Grand Lakes.	Low	High	IF&W	1998 (will require emergency rule	E. $3,500 for all rivers
Recreational Angling. Hooking mortality of Atlantic salmon caught incidentally by anglers fishing for chain pickerel or bass.	The ALO regulation will minimize hooking mortality of any salmon that may be hooked by pickerel and bass anglers	Low	High	IF&W	1998	E
Illegal Fishing	Increase penalties for poaching	Medium	High	IF&W	1997	E
Illegal Fishing. Poaching of adult salmon	Staff all warden districts in the 7 drainage and hire 2 seasonal wardens. Assign top priority to prevention of poaching for wardens in districts where poaching is likely.	High	Medium	IF&W, asa, dmr	1997	N $20,120/year (cost applies to 7 rivers)
Commercial Fishing. Potential for incidental taking of Atlantic salmon adults and juveniles in fyke and/or trap nets used by private citizens in early spring to capture common suckers for lobster bait in Atlantic salmon rivers and their tributaries	IF&W will not permit this activity in any locations having the potential to catch an Atlantic salmon.	Low	High	IF&W	Ongoing	None
Commercial Fishing. Potential for incidental taking of smolts and adult Atlantic salmon in elver fyke nets.	Monitoring of the fishery for Atlantic salmon by-catch will be ongoing. Require exclusion panels.	Low	High	DMR, asa	1997	E

Predation. Adverse effects of harbor seals on adult Atlantic salmon at mouth of rivers.	Study impacts of seals on Atlantic salmon	High	High	DMR, maic	1997	to be determined
	Pursue control of seal populatons if warranted.	High	Low	DMR, maic		to be determined
Predation. Predation on Atlantic salmon smolts by double-crested cormorants.	Study impacts of cormorants on wild AT smolts.	High	High	IF&W/dmr,usfwn, nmfs, universities	1997	N $50,000 over 2 years (cost applies to 7 rivers)
	Pursue control of commarant populations if warranted.	High	Medium	IF&W, dmr,usfwn, nmfs, Universities		to be determined
Wildlife Interactions. Populations of beavers in the 7 drainages have been increasing leading to serious limitations of Atlantic salmon ability to access upstream spawning areas as well as some degradation of Atlantic salmon habitat through impoundments and subsequent stream warming/siltation	Systematically remove key beaver dams with the assistance of Atlantic salmon and wildlife biologists.	High	High	WC, if&w, Project SHARE	Ongoing	N. $3,000 (cost applies to 7 rivers)
Predation and Competition. Depending on their size, splake can prey on or compete with Atlantic salmon..	Monitor splake movements to ensure that they are not taking up residence in Atlantic salmon habitat and identify Atriggers@ whereby splake stocking would be halted.	Low	High	ASA, if&w	Ongoing	E. $500/year (costs apply to 7 rivers)
Predation. Predation on juvenile Atlantic salmon by American eels inhabiting Atlantic salmon nursery habitat	Sample gut contents of American eels captured which electrofishing juvenile salmon habitat to determine food habitats.	Currently unknown	High	ASA, if&w, university	1997, 1998	E

Entity Abbreviations:

ASA - Atlantic Salmon Authority, Maine
ASTF - Atlantic Salmon Task Force (Governor's), Maine
BPC - Board of Pesticide Control, Maine
CES - Cooperative Extension Service
DAFRR - Dept of Agriculture Food and Rural Resources, Maine
DEP - Department of Environmental Protection, Maine
DMR - Department of Marine Resources, Maine
SVCA - Sheepscot Valley Conservation Association
LWRC - Land & Water Resources Council, State Planning Office
IF&W - Inland Fish and Wildlife, Maine
LURC - Land Use Regulatory Commission, Maine
MAIS- Maine Aquaculture Inovation Center
MFS - Maine Forest Service
NRCS - Natural Resources Conservation Service, Federal
NMFS - National Marine Fisheries Service
SHARE - Salmon Habitat and River Enhancement, Project
SWCD - Soil and Water Conservation District, local
USFWS - United States Fish and Wildlife Service, Federal

WC - Watershed Council

Table 5. Machias River and Watershed

Activity Potential Threat to Atlantic Salmon and Its Habitat	Action to Reduce Threat and Promote Recovery	Action Priority	Action Feasibility	Responsible Entities, lead in CAPS	Implementation Date	Cost - Existing, New, Annual with estimates of new funding
Conservation	Adopt watershed management approach and monitor progress	High	High	LWRC	1997	N/E $20,000 for all rivers
	Establish a watershed council	High	High	LWRC	1997	E
Water Use. Agricultural water use has the potential to reduce habitat area and quality of residual habitat, especially in dry summers.	Adopt water use management plan approach	High	High	NRCS, wc, asa, dafrr, dep, if&w, lurc, usfws, Project SHARE	1997	E
	Develop best alternatives from Water Use Management Plan	Medium	High	NRCS, wc, asa, dep, dafrr, dep, if&w, lurc, usfws	1998	E $200,000 $300,000
	Seek funding to implement Water Use Management Plan	Medium	to be determined	LWRC, dafrr	1998 - 2002	N to be determined
Water Use. Temperature of direct discharges has the potential to affect habitat quality.	Define thermal plume associated with direct discharges	High	High	DEP, asa	1997	E
	Reestablish USGS gaging station	High	High	USGS	1997	N to be determined
Pesticide Use Target Crops	Target integrated crop management educational programs and promote use of best management practices on blueberries and cranberries	Medium	High	UMCE, bpc, swcd, nrcs	ongoing	E A $3,000

Hexazinone Use	Implement Hexazinone State Management Plan for the Protection of Groundwater and monitor effectiveness of best management practices	Medium	High	BPC, growers, umce	ongoing	E A $1,000
Agricultural Practices Agricultural practices have the potential to cause nonpoint source pollution, thereby affecting habitat quality.	Implement non-point source pollution and technical assistance programs to assist growers in adopting applicable practices (best management practices) and monitor effectiveness.	Low	High	SWCD, nrcs, umce, dafrr	1997 - 1998	N $20,000/2 years (costs apply to 7 rivers)
Agricultural Practices Improper biosolids use can cause non-point source pollution.	Maintain DEP siting standards and have ASA review permit applications	Low	High	DEP, asa	ongoing	E
Agricultural Practices Wetlands alterations may affect functions important to habitat and water quality.	Develop inventory of moderate and high value wetlands in watershed	Low	High	WC, dep, lurc	ongoing	E
Oil, Fuel + Contaminant Mgt. If spilled into habitat these products are toxic to Atlantic salmon.	Maintain programs for handling oil, fuel, pesticides and other potential contaminates. Respond to all accidental spills	Low	High	DEP, bpc	ongoing	E
Peat Mining Peat mines may affect habitat.	Review application for new mine	High	High	LURC, dep, if&w, asa	ongoing	E

Aquaculture. Escaped Atlantic salmon of aquaculture origin pose risks of: genetic interchange with wild Atlantic salmon, superimposition of redds over those of wild salmon, & competition between river-specific & farmed fish offspring.	Construct weirs on salmon rivers to enumerate wild runs & selectively remove farmed salmon to prevent interactions.	High	High	ASA/usfws, nmfs, project SHARE	1997	N. $565,000 for site & construction $10,000 for operation and maintenance
	River specific stock rehabilitation (rear river-specific stocks in sea cages & release adults or progeny back into parent streams).	High	High	MAIC, aquaculture industry, asa, usfw, nmfs	Ongoing	N. Per river: Rear /Mark/Stock: $61,000 Coordinate/Evaluate: $100,000
	Seal Damage Control • Maintain efforts to reduce seal access to primary containment nets on sea cages through use of double bottoms, predator curtains and/or acoustic deterrents, as needed, particularly in winter; continue regular removal of mortalities from cage bottoms • Include seal attack prevention in Loss Control Code of Practice • Research behavior of seal populations and individuals in vicinity of sea cages; research site and cage design characteristics for vulnerability to seal attack; improve attack incidence and loss documentation within industry	High	Medium	DMR, maic, nmfs	1998	N. Seal behavior study: $250,000 Selective Seal removal (experimental) $100,000 Selective Seal removal (industry wide): $300,000
	Escape Prevention • Maintain efforts to limit the impact of storms and winter sea conditions through careful site selection, regular equipment maintenance, storm preparation and gear inspection and post-storm gear inspection and repair • Develop and adopt industry-driven Loss Control Code of Practice to refine and transfer most effective husbandry practices through the industry	High	High	DMR, maic	1997	Develop Code: management practices: $10,000. Annual Compliance Inspections: $3,000 (costs apply to 7 rivers)

	Universal Marking • Research efficient, cost effective and market-acceptable means of marking farm reared salmon at an existing handling point in the production process, to aid, in conjunction with weirs, easier identification and removal of farm origin strays that enter salmon rivers • Convene joint Maine/US/Canadian workshop to harmonize marking policy when appropriate means becomes available	Medium	Low	AQUACULTURE INDUSTRY, dmr, maic, asa, nmfs	1998	N. $100,000 for all rivers N. US/Canada Workshop: $2,500 (costs apply to 7 rivers)
	Use of Sterile Fish for Aquaculture Continue to monitor world research into biology and commercialization of triploid or other sterile salmon	Low	Low	DMR, maic, nmfs	Unknown	N/A
Aquaculture. Diseases in farmed salmon may be transmitted to wild ATS.	Fish Health Maintain third-party inspection and certification of hatcheries; continue placement of certified, disease-free fish in sea cages; continue vaccination of smolt prior to placement; maintain health monitoring and intervention efforts at sea cage sites Maintain state control over fish health standards and movement of fish into and around the state Develop emergency disease eradication plan; expand the fish health monitoring project to include a full epidemiological study Develop and adopt industry-driven Fish Health Code of Practice to refine and transfer most effective husbandry practices through the industry	Medium	High	DAFRR, dmr, if&w, aquaculture industry, maic	Ongoing	N. Full epid. monitoring program: $200,000 (costs apply to 7 rivers)
Aquaculture. Escape of aquaculture smolts during transfer to sea cages or transmission of diseases from aquaculture smolts to coastal water adjacent	Vaccinate smolts against naturally occurring pathogens in nearshore coastal environments. Inspect smolts for fish health status prior to	Low	High	DAFRR, dmr, aquaculture industry	Ongoing	N. Full epid. monitoring program: $200,000 (costs

to the seven salmon rivers.	transfer. Deny transfer permit if inspection detects pathogens of significant concern to Atlantic salmon. Include smolt transfer procedures in Loss Control Code of Practice.			industry		apply to 7 rivers)
Aquaculture. Presence of farmed salmon in sea cages may become source of pathogens/parasites that could be passed onto wild salmon smolts or adults moving thru the area. Water quality reduction could occur from poor aquaculture practice.	Continue placement of vaccinated, certified, disease-free fish in sea cages; maintain health monitoring and intervention efforts at sea cage sites; develop and adopt industry-driven Fish Health Code of Practice to refine and transfer most effective husbandry practices through the industry. Continue DMR aquaculture lease monitoring programs to assure compliance w/water quality standards. Continue fish health inspection/vaccination/monitoring programs.	Medium	High	AQUACULTURE INDUSTRY, maic, dmr	Ongoing	N/A
Aquaculture. Loss of farmed salmon from sea cages could result in escapees entering salmon rivers and interacting with naturally-spawned populations.	Develop and adopt industry-driven Loss Control Code of Practice to refine and transfer most effective husbandry practices through the industry.	High	High	AQUACULTURE INDUSTRY, maic, dmr	19978	N. Develop Code: $10,000; Annual compliance inspections $3,000 (Costs apply to 7 rivers)
Aquaculture. Loss of farmed salmon during harvest of production fish could result in escapes entering salmon rivers & interacting with wild salmon.	Adopt best practical management practices when harvesting salmon. Salmon are harvested year ›round as market demand dictates. The potential impact would be greatest in the fall when handling sexually mature fish which could potentially escape. Harvest Items Maintain loss control efforts to schedule harvests around sea and weather conditions that limit risk to crews and crop; continue container transport of live-harvest fish; continue anesthetization of sea-killed fish Include harvest techniques in Loss Control Code of Practice	Low	High	AQUACULTURE INDUSTRY, maic, dmr	Ongoing	N/A
Aquaculture. Spawning of brood stock & egg procurements could lead to transmission of diseases acquired at cage sites to freshwater rearing facilities via eggs. Diseased brood stock may infect wild salmon smolts or adults that pass thru the area in the vicinity of brood stock.	All brood stock used to produce eggs are either lethally sampled or reproductive fluids sampled to test for pathogens. Paired matings & tracking of egg lots of known parentage allows eggs from infected parents to be discarded. All eggs are disinfected prior to movement to freshwater	High	High	AQUACULTURE INDUSTRY, maic, dmr	Ongoing	N/A

thru the area in the vicinity of brood stock.	hatcheries in accordance w/prescribed fish health procedures. Brood stock are vaccinated to protect against disease in the wild.					
Forestry. % of watershed in a regenerating forest condition effects water flow dynamics that may alter available habitat	Assess the potential for abnormal flow in the watersheds using remote sensing and model hydrology dynamics and present finding to local watershed councils	High	High	MFS, landowners	1998, 1999	N/E $20,000 (cost applys to all seven rivers)

Land Uses. Land managers and developers may unwittingly disturb important Atlantic salmon habitat through various land use activities including forest management	The Atlantic Salmon Authority completes its habitat mapping and assessment work	High	High	ASA, usfws, Project SHARE	1997	N $45,192 (costs apply to 7 rivers; work complete on several rivers)
	The State Planning Office, Atlantic Salmon Authority, and the Maine Department of Inland Fisheries and Wildlife will cooperatively work with landowners to develop Memoranda of Agreement (MOA) and conservation easements for the protection of all important Atlantic salmon habitat.	High	Medium	SPO, asa, if&w, landowners, wc	1997-1998	E. $40,000 (costs apply to 7 rivers)
	In the absence of comprehensive landowner MOAs or conservation easements, the Land & Water Resources Council will evaluate the designation of "significant Atlantic salmon habitat"	High	Medium	LWRC	1997	E
	DEP, working with landowners and the watershed council, will encourage municipalities to place "significant Atlantic salmon habitat" in a Resource Protection zone.	High	Medium	DEP, spo, asa, Project SHARE, wc	1997-1998	E. $7,000 (costs apply to 7 rivers)
	LURC, working with landowners, Project SHARE and watershed councils, will incorporate Atlantic salmon habitat mapping by rezoning these areas to a Fish and Wildlife Protection Subdistrict with standards for activities in the habitat zones.	High	High	LURC, asa, Project SHARE, wc	1998	E. $2500 (costs apply to 7 rivers)
Forestry. Skid trails, road construction, maintenance, & placement may cause secondary impacts that affect salmon such as: ❶ sedimentation which may clog spawning beds & hinder alevin emergence; ❷ poor culvert installation which blocks fish passage; and ❸ increased access which may create greater fishing pressure	ì&❷ State agencies will work with Project SHARE to design and implement an ongoing program to educate road building and logging contractors and landowners on the importance of Atlantic salmon habitat and to promote the use of forestry best management practices.	Medium	High	MFS, project SHARE, dep, lurc, spo, wc, landowners	1997 and beyond	ì&❷N. $25,000 (costs apply to 7 rivers)

	î Resource agencies working with Project SHARE, landowners, and others will cooperatively monitor key access points and control access where necessary and appropriate.	Medium	Low	ÐWC, project SHARE, if&w, angling groups, landowners	1997	î N. $10,000 (costs apply to 7 rivers)
Forestry. Increased temperatures and algal blooms from excessive shade removal along streams can adversely affect Atlantic salmon survival by changing their feeding, reproductive, and migratory behavior, reducing suitable rearing habitat and available cold water refugia , and eliminating macroinvertebrate habitat	Increased enforcement and compliance monitoring of shoreland harvesting	Medium	High	DEP/LURC, if&w, mfs, watershed council, Project SHARE, municipalities	1997 and beyond	E. $20,000 (costs apply to 7 rivers)
	Educate logging contractors and resource managers to be sensitive to shading needs when planning tree harvesting in shoreland areas.	High	High	PROJECT SHARE/ mfs	1997 - 2000	N. $5,000 (costs apply to 7 rivers)
Forestry. Excessive woody debris blocking fish passage, restricting stream flow, and reducing dissolved oxygen	Remove blockages with advice from fisheries biologists	Medium	High	PROJECT SHARE, wc, if&w, asa	ongoing	E
General Pesticide Use. Pesticide use has the potential to threaten Atlantic salmon if pesticides are present at levels that cause acute or chronic effects. Toxicity varies with chemicals.	DEP, ASA, & BPC will review will review the geographic usage of pesticides in the seven watersheds and DEP will target areas for in-stream assessment.	Medium	High	DEP, bpc, asa	1998 - 2000	E
	The Board of Pesticide Control will work cooperatively with the Department of Agriculture, Food & Rural Resources and other state agencies and the Cooperative Extension Service to update best management practices based on the latest research and promote the use of these practices within the seven river watersheds.	Medium	High	BPC, state agencies, Univ. of ME.	1997 and beyond	E
	The Board of Pesticide Control will respond to evidence of pesticides causing adverse environmental effects by proposing amendments to its regulations, updating best management practices, and changing product registration status where appropriate.	Medium	High	BPC	1997 ongoing	E
Recreational Angling. Incidental take associated with ATS angling	Severely limit catch and release fishery: restrictions on time (May 1-June 15, Sept. 15-Oct.	High	High	ASA	1997 - 1998	E. $3,500 (costs apply to 7 rivers)

with ATS angling	15), location (provide an upriver sanctuary for salmon), and gear (no nets, barbless hooks).					apply to 7 rivers)
Recreational Angling. Taking of juvenile Atlantic salmon by trout anglers who misidentify the species. Hooking mortality of juvenile Atlantic salmon caught incidentally by brook trout, landlocked salmon, and brown trout anglers.	Change fishing regulations in seven rivers and major tributaries (7/1-8/15) to: ALO minimum length on trout 8"; keep bag limit at 5; 7/1-9/30 current regulations but minimum length on trout is 8".	High	High	IF&W	1998	E
Recreational Angling. Adult Atlantic salmon are suseptable to angling in cold water holding areas.	Monitor cold water holding areas and close to all fishing as necessary.	High	High	IF&W	1997 and beyond	E
Recreational Angling. Hooking mortality of Atlantic salmon caught incidentally by anglers fishing for chain pickerel or bass.	The ALO regulation will minimize hooking mortality of any salmon that may be hooked by pickerel and bass anglers	Low	High	IF&W	1998	E
Recreational Angling. Potential of keeping an Atlantic salmon kelt taken in a lake by ice fishing as a "large trophy-sized Landlocked salmon or brown trout@ resulting in the taking of an Atlantic salmon.	Promulgate new regulation establishing a 25" maximum size on Landlocked salmon in al of Washington County, except East Grand and West Grand Lakes.	Low	High	IF&W/dmr	1998	E
Illegal Fishing	Increase penalties for poaching	Medium	High	IF&W	1997	E
Illegal Fishing. Poaching of adult salmon	Staff all warden districts in the 7 drainage and hire 2 seasonal wardens. Assign top priority to prevention of poaching for wardens in districts where poaching is likely.	High	Medium	IF&W, asa, dmr	1997	N $20,120/year (cost applies to 7 rivers)
Commercial Fishing. Potential for incidental taking of Atlantic salmon adults and juveniles in fyke and/or trap nets used by private citizens in early spring to capture common suckers for lobster bait in ATS rivers and their tributaries	IF&W will not permit this activity in any locations having the potential to catch an Atlantic salmon.	Low	High	IF&W	Ongoing	E
Commercial Fishing. Potential for incidental taking of smolts and adult Atlantic salmon in elver fyke nets.	Monitoring of the fishery for Atlantic salmon by-catch will be ongoing. Recommend exclusion panels.	Low	High	DMR, asa	1996	E
Predation. Predation on Atlantic salmon fry, juveniles, or smolts by larger splake.	Monitor splake movements to ensure that they are not taking up residence in ATS habitat and identify	Presently	High	IF&W, asa	Ongoing	E. $500/year (costs

juveniles, or smolts by larger splake.	Atriggers@ whereby SPK stocking would be halted.	unknown				apply to 7 rivers)
Predation and Competition. Depending on their size, brown trout can prey on or compete with Atlantic salmon.	Monitor brown trout movements to ensure that they are not taking up residence in Atlantic salmon habitat and identify Atriggers@ whereby brown trout stocking would be halted.	Low	High	IF&W, asa	Ongoing	E. $500/year (costs apply to 7 rivers)
Predation. Adverse effects of harbor seals on adult Atlantic salmon at mouth of river.	Study impacts of seals on Atlantic salmon.	High	High	DMR/maic	1997	to be determined
	Pursue control of seal populatons if warranted.	High	Low	DMR/maic		to be determined
Predation. Predation on Atlantic salmon smolts by double-crested cormorants.	Study impacts of cormorants on wild Atlantic salmon smolts.	High	High	IF&W/dmr,usfwn, nmfs, Universities	1997	N $50,000 over 2 years (cost applies to 7 rivers)
	Pursue control of commarant populations if warranted.	High	Medium	IF&W/dmr,usfwn, nmfs, Universities		to be determined
Wildlife Interactions. Populations of beavers in the 7 drainages have been increasing leading to serious limitations of Atlantic salmon ability to access upstream spawning areas as well as some degradation of Atlantic salmon habitat through impoundments and subsequent stream warming/siltation	Systematically remove key beaver dams with the assistance of Atlantic salmon and wildlife biologists.	High	High	WC, asa, if&w, Project SHARE	Ongoing	N. $3,000 (costs apply to 7 rivers)
Predation. Pickerel predation on smolts can reduce their numbers. The degree to which this occurs depends on the abundance of pickerel in areas smolts must migrate through en route to the ocean.	Promulgate new regulation on the mainstream of each Atlantic salmon river and no major Atlantic salmon - producing tributaries: No bag limit on Pickerel.	Medium	High	IF&W	1998	A. $3,500 total for all rule changes (costs apply to 7 rivers)
Predation. Predation on juvenile Atlantic salmon by American eels inhabiting Atlantic salmon nursery habitat	Sample gut contents of American eels captured which electrofishing juvenile salmon habitat to determine food habitats.	Currently unknown	High	ASA, if&w, university	1997 - 1998	E.

Entity Abbreviations:

ASA - Atlantic Salmon Authority, Maine
ASTF - Atlantic Salmon Task Force (Governor's), Maine

IF&W - Inland Fish and Wildlife, Maine
LURC - Land Use Regulatory Commission, Maine

BPC - Board of Pesticide Control, Maine
CES - Cooperative Extension Service
DAFRR - Dept of Agriculture Food and Rural Resources, Maine
DEP - Department of Environmental Protection, Maine
DMR - Department of Marine Resources, Maine
SVCA - Sheepscot Valley Conservation Association
LWRC - Land & Water Resources Council, State Planning Office
MAIS- Maine Aquaculture Inovation Center
MFS - Maine Forest Service
NRCS - Natural Resources Conservation Service, Federal
NMFS - National Marine Fisheries Service
SHARE - Salmon Habitat and River Enhancement, Project
SWCD - Soil and Water Conservation District, local
USFWS - United States Fish and Wildlife Service, Federal
WC - Watershed Council

Table 6. East Machias River and Watershed

Activity Potential Threat to Atlantic Salmon and Its Habitat	Action to Reduce Threat and Promote Recovery	Action Priority	Action Feasibility	Responsible Entities, lead in CAPS	Implementation Date	Cost - Existing, New, Annual with estimates of new funding
Conservation	Adopt watershed management approach and monitor progress	High	High	LWRC	1997	N/E $20,000 for all rivers
	Establish a watershed council	High	High	LWRC	1997	N. $20,000
Pesticide Use Target Crops	Target integrated crop management educational programs and promote use of best management practices on blueberries and cranberries	Medium	High	UMCE, bpc, swcd, nrcs	ongoing	E A $3,000
Hexazinone Use	Implement Hexazinone State Management Plan for the Protection of Groundwater and monitor effectiveness of best management practices	Medium	High	BPC, umce, growers	ongoing	E A $1,000
Agricultural Practices Agricultural practices have the potential to cause nonpoint source pollution, thereby affecting habitat quality.	Implement non-point source and technical assistance programs to assist growers in adopting applicable practices (best management practices) and monitor effectiveness.	Low	High	SWCD, nrcs, umce, dafrr	1997 - 1998	N $20,000 /2 years (costs apply to 7 rivers)
Agricultural Practices Improper biosolids use can cause nonpoint source pollution.	Maintain DEP siting standards and have ASA review permit applications	Low	High	DEP, asa	ongoing	E
Agricultural Practices Wetlands alterations may affect functions important to habitat and water quality	Develop inventory of moderate and high value wetlands in watershed.	Low	High	DEP, WC	ongoing	E
Oil, Fuel + Contaminant Mgt. If spilled into habitat these products may be toxic to Atlantic salmon.	Maintain programs for handling oil, fuel, pesticides and other potential contaminates. Respond to all accidental spills	Low	High	DEP, bpc	ongoing	E

Aquaculture. Escaped Atlantic salmon of aquaculture origin pose risks of: genetic interchange with wild Atlantic salmon, superimposition of redds over those of wild salmon, & competition between river-specific & farmed fish offspring	Construct weirs on salmon rivers to enumerate wild runs & selectively remove farmed salmon to prevent interactions.	High	High	ASA, usfws, nmfs, Project SHARE	1997	N $266,000 for site & construction $10,000 for operation and maintenance
	River specific stock rehabilitation (rear river-specific stocks in sea cages & release adults or progeny back into parent streams).	High	High	MAIC, aquaculture industry, asa, usfw, nmfs	Ongoing	N. Per river: Rear /Mark/Stock: $61,000 Coordinate/Evaluate: $100,000
	Seal Damage Control • Maintain efforts to reduce seal access to primary containment nets on sea cages through use of double bottoms, predator curtains and/or acoustic deterrents, as needed, particularly in winter; continue regular removal of mortalities from cage bottoms • Include seal attack prevention in Loss Control Code of Practice • Research behavior of seal populations and individuals in vicinity of sea cages; research site and cage design characteristics for vulnerability to seal attack; improve attack incidence and loss documentation within industry	High	Medium	DMR, maic, nmfs	1998	N. Seal behavior study: $250,000 Selective Seal removal (experimental) $100,000 Selective Seal removal (industry wide): $300,000
	Escape Prevention • Maintain efforts to limit the impact of storms and winter sea conditions through careful site selection, regular equipment maintenance, storm preparation and gear inspection and post-storm gear inspection and repair • Develop and adopt industry-driven Loss Control Code of Practice to refine and transfer most effective husbandry practices through the industry	High	High	DMR, maic	1997	N. Develop Code: management practices: $10,000. Annual Compliance Inspections: $3,000 (costs apply to 7 rivers)

	Universal Marking • Research efficient, cost effective and market-acceptable means of marking farm reared salmon at an existing handling point in the production process, to aid, in conjunction with weirs, easier identification and removal of farm origin strays that enter salmon rivers • Convene joint Maine/US/Canadian workshop to harmonize marking policy when appropriate means becomes available	Medium	Low	AQUACULTURE INDUSTRY, dmr, maic, asa, nmfs	1998	N. $100,000 for all rivers N. US/Canada Workshop: $2,500 (costs apply to 7 rivers)
	Use of Sterile Fish for Aquaculture • Continue to monitor world research into biology and commercialization of triploid or other sterile salmon	Low	Low	DMR, maic	Unknown	N/A
Aquaculture. Diseases in farmed salmon may be transmitted to wild Atlantic salmon.	Fish Health • Maintain third-party inspection and certification of hatcheries; continue placement of certified, disease-free fish in sea cages; continue vaccination of smolt prior to placement; maintain health monitoring and intervention efforts at sea cage sites • Maintain state control over fish health standards and movement of fish into and around the state • Develop emergency disease eradication plan; expand the fish health monitoring project to include a full epidemiological study • Develop and adopt industry-driven Fish Health Code of Practice to refine and transfer most effective husbandry practices through the industry	Medium	High	DAFRR, dmr, if&w, aquaculture industry, maic	Ongoing	N. Full epid. monitoring program: $200,000 (costs apply to 7 rivers)

Aquaculture. Escape of aquaculture smolts during transfer to sea cages or transmission of diseases from aquaculture smolts to coastal water adjacent to the seven salmon rivers.	Vaccinate smolts against naturally occurring pathogens in nearshore coastal environments. Inspect smolts for fish health status prior to transfer. Deny transfer permit if inspection detects pathogens of significant concern to Atlantic salmon. Include smolt transfer procedures in Loss Control Code of Practice.	Low	High	DAFRR, dmr, aquaculture industry	Ongoing	N. Full epid. monitoring program: $200,000 (costs apply to 7 rivers)
Aquaculture. Presence of farmed salmon in sea cages may become source of pathogens/parasites that could be passed onto wild salmon smolts or adults moving thru the area. Water quality reduction could occur from poor aquaculture practice.	Continue placement of vaccinated, certified, disease-free fish in sea cages; maintain health monitoring and intervention efforts at sea cage sites; develop and adopt industry-driven Fish Health Code of Practice to refine and transfer most effective husbandry practices through the industry. Continue DMR aquaculture lease monitoring programs to assure compliance w/water quality standards. Continue fish health inspection/vaccination/monitoring programs.	Medium	High	AQUACULTURE INDUSTRY, maic, dmr	Ongoing	N/A
Aquaculture. Loss of farmed salmon from sea cages could result in escapees entering salmon rivers and interacting with naturally-spawned populations.	Develop and adopt industry-driven Loss Control Code of Practice to refine and transfer most effective husbandry practices through the industry.	High	High	AQUACULTURE INDUSTRY, maic, dmr	1997	N. Develop Code: $10,000; Annual compliance inspections $3,000 (Costs apply to 7 rivers)
Aquaculture. Loss of farmed salmon during harvest of production fish could result in escapes entering salmon rivers & interacting w/ wild salmon.	Adopt best practical management practices when harvesting salmon. Salmon are harvested year ›round as market demand dictates. The potential impact would be greatest in the fall when handling sexually mature fish which could potentially escape. Harvest Items • Maintain loss control efforts to schedule harvests around sea and weather conditions that limit risk to crews and crop; continue container transport of live-harvest fish; continue anesthetization of sea-killed fish • Include harvest techniques in Loss Control Code of Practice	Low	High	AQUACULTURE INDUSTRY, maic, dmr	Ongoing	N/A

Aquaculture. Spawning of brood stock & egg procurement could lead to transmission of diseases acquired at cage sites to freshwater rearing facilities via eggs. Diseased brood stock may infect wild salmon smolts or adults that pass thru the area in the vicinity of brood stock.	All brood stock used to produce eggs are either lethally sampled or reproductive fluids sampled to test for pathogens. Paired matings & tracking of egg lots of known parentage allows eggs from infected parents to be discarded. All eggs are disinfected prior to movement to freshwater hatcheries in accordance w/prescribed fish health procedures. Brood stock are vaccinated to protect against disease in the wild.	High	High	AQUACULTURE INDUSTRY, maic, dmr	Ongoing	N/A
Forestry. % of watershed in a regenerating forest condition effects water flow dynamics that may alter available habitat	Assess the potential for abnormal flow in the watersheds using remote sensing and model hydrology dynamics and present finding to local watershed councils	High	High	MFS, landowners	1998, 1999	N/E $20,000 (cost applies to all seven rivers)

Land Uses. Land managers and developers may unwittingly disturb important Atlantic salmon habitat through various land use activities including forest management	The Atlantic Salmon Authority completes its habitat mapping and assessment work	High	High	ASA, usfws, Project SHARE	1997	N. $45,192 (costs apply to 7 rivers; work is complete on several rivers)
	The State Planning Office, Atlantic Salmon Authority, and the Maine Department of Inland Fisheries and Wildlife will cooperatively work with landowners to develop Memoranda of Agreement (MOA) and conservation easements for the protection of all important Atlantic salmon habitat.	High	Medium	SPO, asa, if&w, landowners, wc	1997-2001	E. $40,000 (costs apply to 7 rivers)
	In the absence of comprehensive landowner MOAs or conservation easements, the Land & Water Resources Council will evaluate the designation of "significant Atlantic salmon habitat"	High	Medium	LWRC	1999	E
	DEP, working with landowners and the watershed council, will encourage municipalities to place "significant Atlantic salmon habitat" in a Resource Protection zone.	High	Medium	DEP, spo, asa, Project SHARE, wc	1997-1998	E. $7,000 (costs apply to 7 rivers)
	LURC, working with landowners, Project SHARE and watershed councils, will incorporate Atlantic salmon habitat mapping by rezoning these areas to a Fish and Wildlife Protection Subdistrict with standards for activities in the habitat zones.	High	High	LURC, asa, Project SHARE, wc	1998	E. $2500 (costs apply to 7 rivers)
Forestry. Skid trails, road construction, maintenance, & placement may cause secondary impacts that affect salmon such as: ❶ sedimentation which may clog spawning beds & hinder alevin emergence; ❷ poor culvert installation which blocks fish passage; and ❸ increased access which may create greater fishing pressure	ì&❷ State agencies will work with Project SHARE to design and implement an ongoing program to educate road building and logging contractors and landowners on the importance of Atlantic salmon habitat and to promote the use of forestry best management practices.	Medium	High	MFS, project SHARE, dep, lurc, spo, wc, landowners	1997 and beyond	ì&❷ N. $25,000 (costs apply to 7 rivers)

	î Resource agencies working with Project SHARE, landowners, and others will cooperatively monitor key access points and control access where necessary and appropriate.	Medium	Low	ÐWC, project SHARE, if&w, angling groups, landowners	1997	Î N $10,000 (costs apply to 7 rivers)
Forestry. Increased temperatures and algal blooms from excessive shade removal along streams can adversely affect Atlantic salmon survival by changing their feeding, reproductive, and migratory behavior, reducing suitable rearing habitat and available cold water refugia , and eliminating macroinvertebrate habitat	Increased enforcement and compliance monitoring of shoreland harvesting	Medium	High	DEP, LURC, if&w, mfs, watershed council, Project SHARE, municipalities	1997 and beyond	Î E. $20,000 (costs apply to 7 rivers)
	Educate logging contractors and resource managers to be sensitive to shading needs when planning tree harvesting in shoreland areas.	High	High	PROJECT SHARE, mfs	1997 - 2000	N $5,000 (costs apply to 7 rivers)
Forestry. Excessive woody debris blocking fish passage, restricting stream flow, and reducing dissolved oxygen	Remove blockages with advice from fisheries biologists	Low	High	wc, PROJECT SHARE, if&w, asa	ongoing	E
General Pesticide Use. Pesticide use has the potential to threaten Atlantic salmon if pesticides are present at levels that cause acute or chronic effects. Toxicity varies with chemicals	DEP, ASA, & BPC will review will review the geographic usage of pesticides in the seven watersheds and DEP will target areas for in-stream assessment.	Medium	Low	DEP, bpc, asa	1998 - 2000	E
	The Board of Pesticide Control will work cooperatively with state agencies and the University of Maine Co-operative Extension Service to update best management practices based on the latest research and promote the use of these practices within the seven river watersheds.	Medium	High	BPC, state agencies, univ. of Maine	1997 and beyond	E
	The Board of Pesticide Control will respond to evidence of pesticides causing adverse environmental effects by proposing amendments to its regulations, updating best management practices, and changing product registration status where appropriate.	Medium	High	BPC	1997 ongoing	E
Recreational Angling. Incidental take associated with ATS angling	Severely limit catch and release fishery: restrictions on time (May 1-June 15, Sept. 15-Oct. 15), location (provide an upriver sanctuary for salmon), and gear (no nets, barbless hooks).	High	High	ASA	1997 - 1998	E $3,500 (costs apply to 7 rivers)

Recreational Angling. Taking of juvenile Atlantic salmon by trout anglers who misidentify the species. Hooking mortality of juvenile Atlantic salmon caught incidentally by brook trout, landlocked salmon, and brown trout anglers.	Change fishing regulations in seven rivers and major tributaries (7/1-8/15) to: ALO minimum length on trout 8"; keep bag limit at 5; 7/1-9/30 current regulations but minimum length on trout is 8".	High	High	IF&W	1998	None
Recreational Angling. Potential of keeping an Atlantic salmon kelt taken in a lake by ice fishing as a "large trophy-sized Landlocked salmon or brown trout@ resulting in the taking of an Atlantic salmon.	Promulgate new regulation establishing a 25" minimum size on Landlocked salmon in all of Washington County, except West Grand and East Grand Lakes.	High	High	IF&W, dmr	1998 (will require emergency rule	E. $3,500 total for all rule changes (costs apply to 7 rivers)
Recreational Angling. Adult Atlantic salmon are suseptable to angling in cold water holding areas.	Monitor cold water holding areas and close to all fishing as necessary.	High	High	IF&W	1997 and beyond	E
Recreational Angling. Hooking mortality of Atlantic salmon caught incidentally by anglers fishing for chain pickerel or bass.	The ALO regulation will minimize hooking mortality of any salmon that may be hooked by pickerel and bass anglers	Low	High	IF&W	1998	E
Illegal Fishing	Increase penalties for poaching	Medium	High	IF&W	1997	E
Illegal Fishing. Poaching of adult salmon	Staff all warden districts in the 7 drainage and hire 2 seasonal wardens. Assign top priority to prevention of poaching for wardens in districts where poaching is likely.	High	Medium	IF&W, asa, dmr	1997	N $20,120/year (cost applies to 7 rivers)
Commercial Fishing. Potential for incidental taking of Atlantic salmon adults and juveniles in fyke and/or trap nets used by private citizens in early spring to capture common suckers for lobster bait in Atlantic salmon rivers and their tributaries	IF&W will not permit this activity in any locations having the potential to catch an Atlantic salmon.	Low	High	IF&W	Ongoing	E
Commercial Fishing. Potential for incidental taking of smolts and adult Atlantic salmon in elver fyke nets.	Monitoring of the fishery for Atlantic salmon by-catch will be ongoing. Recommend exclusion panels.	Low	High	DMR, asa	1996	E

Predation. Adverse effects of harbor seals on adult Atlantic salmon at mouth of rivers.	Study impacts of seals on Atlantic salmon.	High	High	DMR, maic	1997	to be determined
	Pursue control of seal populatons if warranted.	High	Low	DMR, maic		to be determined
Predation. Predation on Atlantic salmon smolts by double-crested cormorants.	Study impacts of cormorants on wild AT smolts.	High	High	IF&W, dmr,usfwn, nmfs, Universities	1997	N $50,000 over 2 years (cost applies to 7 rivers)
	Pursue control of commarant populations if warranted.	High	Medium	IF&W, dmr,usfwn, nmfs, Universities		to be determined
Predation and Competition. Predation and competition between Atlantic salmon and brown trout.	Monitor brown trout movements to ensure that they are not taking up residence in Atlantic salmon habitat and identify Atriggers@ whereby brown trout stocking would be halted.	Low	High	IF&W, asa	Ongoing	E. $500/year (costs apply to 7 rivers)
Wildlife Interactions. Populations of beavers in the 7 drainages have been increasing leading to serious limitations of Atlantic salmon ability to access upstream spawning areas as well as some degradation of Atlantic salmon habitat through impoundments and subsequent stream warming/siltation	Systematically remove key beaver dams with the assistance of Atlantic salmon and wildlife biologists.	High	High	WC, if&w, asa, Project SHARE	Ongoing	N. $3,000 (costs apply to 7 rivers)
Predation. Pickerel predation on smolts can reduce their numbers. The degree to which this occurs depends on the abundance of pickerel in areas smolts must migrate through en route to the ocean.	Promulgate new regulation on the mainstream of each Atlantic salmon river and on major salmon - producing tributaries: No bag limit on pickerel.	Medium (overall); Low (Pleasant and Dennys Rivers)	High	IF&W	1998	A. $3,500 total for all rule changes (costs apply to 7 rivers)
Predation. Predation on juvenile Atlantic salmon by American eels inhabiting Atlantic salmon nursery habitat	Sample gut contents of American eels captured which electrofishing juvenile salmon habitat to determine food habitats.	Currently unknown	High	ASA, if&w, university	1996	E.

Competition and Hybridization. Potential for landlocked salmon and Atlantic salmon to spawn together; competition for food and space between landlocked salmon and Atlantic salmon on nursery habitat.	Screen Meddybemps Lake each fall to prevent landlocked salmon from leaving the lake to spawn.	High	High	ASA, if&w	Ongoing	$200 for adequate screen at upstream end of Meddybemps fishway

Entity Abbreviations:

ASA - Atlantic Salmon Authority, Maine
ASTF - Atlantic Salmon Task Force (Governor's), Maine
BPC - Board of Pesticide Control, Maine
CES - Cooperative Extension Service
DAFRR - Dept of Agriculture Food and Rural Resources, Maine
DEP - Department of Environmental Protection, Maine
DMR - Department of Marine Resources, Maine
SVCA - Sheepscot Valley Conservation Association
LWRC - Land & Water Resources Council, State Planning Office
IF&W - Inland Fish and Wildlife, Maine
LURC - Land Use Regulatory Commission, Maine
MAIS- Maine Aquaculture Inovation Center
MFS - Maine Forest Service
NRCS - Natural Resources Conservation Service, Federal
NMFS - National Marine Fisheries Service
SHARE - Salmon Habitat and River Enhancement, Project
SWCD - Soil and Water Conservation District, local
USFWS - United States Fish and Wildlife Service, Federal
WC - Watershed Council

Table 7. Dennys River and Watershed

Activity Potential Threat to Atlantic Salmon and Its Habitat	Action to Reduce Threat and Promote Recovery	Action Priority	Action Feasibility	Responsible Entities, lead in CAPS	Implementation Date	Cost - Existing, New, Annual with estimates of new funding
Conservation	Adopt watershed management approach and monitor progress	High	High	LWRC	1997	N/E $20, 000 for all rivers
	Establish a watershed council	High	High	LWRC	1997	N. $20,000
Pesticide Use Target Crops	Target best management practices educational programs and promote use of best management practices on blueberries and cranberries	Medium	High	UMCE, bpc, swcd, nrcs	ongoing	E A $3,000
Hexazinone Use	Implement Hexazinone State Management Plan for the Protection of Groundwater and monitor effectiveness of best management practices	Medium	High	BPC, umce, growers	ongoing	A $1,000
Agricultural Practices Agricultural practices have the potential to cause nonpoint source pollution, thereby affecting habitat quality.	Implement proactive NPS and technical assistance programs to assist growers in adopting applicable practices (best management practices) and monitor effectiveness.	Low	High	SWCD, nrcs, umce, dafrr	1997 - 1998	N $20,000 /2 years (costs apply to 7 rivers)
Agricultural Practices Improper biosolids use can cause nonpoint source pollution.	Maintain DEP siting standards and have ASA review permit applications	Low	High	DEP, asa	ongoing	E
Agricultural Practices Wetlands alterations may affect functions important to habitat and water quality	Develop inventory of high value wetlands in watershed.	Low	High	WC, dep	ongoing	E
Oil, Fuel + Contaminant Mgt. If spilled into habitat these products may be toxic to Atlantic salmon.	Maintain programs for handling oil, fuel, pesticides and other potential contaminates. Respond to all accidental spills	Low	High	DEP, bpc	Ongoing	E

Aquaculture. Escaped Atlantic salmon of aquaculture origin pose risks of: genetic interchange with wild Atlantic salmon, superimposition of redds over those of wild salmon, & competition between river-specific &	Construct weirs on salmon rivers to enumerate wild runs & selectively remove farmed salmon to prevent interactions.	High	High	ASA, usfws, nmfs	1997	N $259,000 for construction $10,000 for operation and maintenance

	River specific stock rehabilitation (rear river-specific stocks in sea cages & release adults to progeny back into parent streams)	High	High	MAIC, aquaculture industry, asa, usfw, nmfs	Ongoing	N. Per river: Rear /Mark/Stock: $61,000 Coordinate/Evaluate: $100,000
	Seal Damage Control • Maintain efforts to reduce seal access to primary containment nets on sea cages through use of double bottoms, predator curtains and/or acoustic deterrents, as needed, particularly in winter; continue regular removal of mortalities from cage bottoms • Include seal attack prevention in Loss Control Code of Practice • Research behavior of seal populations and individuals in vicinity of sea cages; research site and cage design characteristics for vulnerability to seal attack; improve attack incidence and loss documentation within industry	High	Medium	DMR, maic, nmfs	1998	N. Seal behavior study: $250,000 Selective Seal removal (experimental) $100,000 Selective Seal removal (industry wide): $300,000
	Escape Prevention • Maintain efforts to limit the impact of storms and winter sea conditions through careful site selection, regular equipment maintenance, storm preparation and gear inspection and post-storm gear inspection and repair • Develop and adopt industry-driven Loss Control Code of Practice to refine and transfer most effective husbandry practices through the industry	High	High	DMR, maic	1997	N. Develop best management practices: $10,000 Annual Compliance Inspections: $3,000 (costs apply to 7 rivers)

	Universal Marking • Research efficient, cost effective and market-acceptable means of marking farm reared salmon at an existing handling point in the production process, to aid, in conjunction with weirs, easier identification and removal of farm origin strays that enter salmon rivers • Convene joint Maine/US/Canadian workshop to harmonize marking policy when appropriate means becomes available	Medium	Low	AQUACULTURE INDUSTRY, NMFS, dmr, maic, asa	1997	N. $100,000 for all rivers N. US/Canada Workshop: $2,500 (costs apply to 7 rivers)
	Use of Sterile Fish for Aquaculture • Continue to monitor world research into biology and commercialization of triploid or other sterile salmon	Low	Low	DMR, maic	Unknown	N/A
Aquaculture. Diseases in farmed fish may be transmitted to wild Atlantic salmon.	Fish Health • Maintain third-party inspection and certification of hatcheries; continue placement of certified, disease-free fish in sea cages; continue vaccination of smolt prior to placement; maintain health monitoring and intervention efforts at sea cage sites • Maintain state control over fish health standards and movement of fish into and around the state • Develop emergency disease eradication plan; expand the fish health monitoring project to include a full epidemiological study • Develop and adopt industry-driven Fish Health Code of Practice to refine and transfer most effective husbandry practices through the industry	High	High	DAFRR, dmr, if&w, aquaculture industry, maic	Ongoing	N. Full epid. monitoring program: $200,000 (costs apply to 7 rivers)
Aquaculture. Escape of aquaculture smolts during transfer to sea cages of transmission of diseases from aquaculture smolts to coastal water adjacent	Vaccinate smolts against naturally occurring pathogens in nearshore coastal environments. Inspect smolts for fish health status prior to	Low	High	DAFRR, dmr, aquaculture	Ongoing	Full epid. monitoring program: $200,000

to seven salmon rivers.	transfer. Deny transfer permit if inspection detects pathogens of significant concern to Atlantic salmon. Include smolt transfer procedures in Loss Control Code of Practice.			industry		(costs apply to 7 rivers)
Aquaculture. Presence of farmed salmon in sea cages may become source of pathogens/parasites that could be passed onto Awild@ salmon smolts or adults moving thru the area. Water quality reduction could occur from poor aquaculture practice.	Continue placement of vaccinated, certified, disease-free fish in sea cages; maintain health monitoring and intervention efforts at sea cage sites; develop and adopt industry-driven Fish Health Code of Practice to refine and transfer most effective husbandry practices through the industry. Continue DMR aquaculture lease monitoring programs to assure compliance w/water quality standards. Continue fish health inspection/vaccination/monitoring programs.	Medium	High	Aquaculture Industry, maic, dmr	Ongoing	N/A
Aquaculture. Loss of farmed salmon from sea cages results in escapees entering salmon rivers and interacting with naturally-spawned populations.	Develop and adopt industry-driven Loss Control Code of Practice to refine and transfer most effective husbandry practices through the industry.	High	High	AQUACULTURE INDUSTRY, maic, dmr	1997	N. Develop Code: $10,000; Annual compliance inspections $3,000 (Costs apply to 7 rivers)
Aquaculture. Loss of farmed salmon during harvest of production fish could result in escapes entering salmon rivers & interacting with wild salmon	Adopt best practical management practices when harvesting salmon. Salmon are harvested year ›round as market demand dictates. The potential impact would be greatest in the fall when handling sexually mature fish which could potentially escape. Harvest Items • Maintain loss control efforts to schedule harvests around sea and weather conditions that limit risk to crews and crop; continue container transport of live-harvest fish; continue anesthetization of sea-killed fish • Include harvest techniques in Loss Control Code of Practice	Low	High	AQUACULTURE INDUSTRY, maic, dmr	Ongoing	N/A
Aquaculture. Spawning of brood stock & egg procurements could lead to transmission of diseases acquired at cage sites to freshwater rearing facilities via eggs. Diseased brood stock may infect wild salmon smolts or adults that pass	All brood stock used to produce eggs are either lethally sampled or reproductive fluids sampled to test for pathogens. Paired matings & tracking of egg lots of known parentage allows eggs from infected parents to be discarded. All eggs are	High	High	AQUACULTURE INDUSTRY, maic, dmr	Ongoing	N/A

thru the area in the vicinity of brood stock.	disinfected prior to movement to freshwater hatcheries in accordance w/prescribed fish health procedures. Brood stock are vaccinated to protect against disease in the wild.					
Forestry. % of watershed in a regenerating forest condition effects water flow dynamics that may alter available habitat	Assess the potential for abnormal flow in the watersheds using remote sensing and model hydrology dynamics and present finding to local watershed councils	High	High	MFS, landowners	1998, 1999	N/E $20,000 (cost applys to all seven rivers)

Land Uses. Land managers and developers may unwittingly disturb important Atlantic salmon habitat through various land use activities including forest management	The Atlantic Salmon Authority completes its habitat mapping and assessment work	High	High	ASA, usfws, Project SHARE	1997	N. $45,192 (costs apply to 7 rivers; work is complete on several rivers)
	The State Planning Office, Atlantic Salmon Authority, and the Maine Department of Inland Fisheries and Wildlife will cooperatively work with landowners to develop Memoranda of Agreement (MOA) and conservation easements for the protection of all important Atlantic salmon habitat.	High	Medium	SPO, asa, if&w, landowners, wc	1997-2001	E. $40,000 (costs apply to 7 rivers)
	In the absence of comprehensive landowner MOAs or conservation easements, the Land & Water Resources Council will evaluate the designation of "significant Atlantic salmon habitat"	High	Medium	LWRC	1999	E
	DEP, working with landowners and the watershed council, will encourage municipalities to place "significant Atlantic salmon habitat" in a Resource Protection zone.	High	Medium	DEP, spo, asa, Project SHARE, wc	1997-1998	E. $7,000 (costs apply to 7 rivers)
	LURC, working with landowners, Project SHARE and watershed councils, will incorporate Atlantic salmon habitat mapping by rezoning these areas to a Fish and Wildlife Protection Subdistrict with standards for activities in the habitat zones.	High	High	LURC, asa, Project SHARE, wc	1998	E. $2500 (costs apply to 7 rivers)
Forestry. Skid trails, road construction, maintenance, & placement may cause secondary impacts that affect salmon such as: ì sedimentation which may clog spawning beds & hinder alevin emergence; í poor culvert installation which blocks fish passage; and î increased access which may create greater fishing pressure	ì&í State agencies will work with Project SHARE to design and implement an ongoing program to educate road building and logging contractors and landowners on the importance of Atlantic salmon habitat and to promote the use of forestry best management practices.	Medium	High	MFS, project SHARE, dep, lurc, spo, wc, landowners	1997 and beyond	ì&í N $25,000 (costs apply to 7 rivers)

	î Resource agencies working with Project SHARE, landowners, and others will cooperatively monitor key access points and control access where necessary and appropriate.	Medium	Low	ĐWC, project SHARE, if&w, angling groups, landowners	1997	î N $10,000 (costs apply to 7 rivers)
Forestry. Increased temperatures and algal blooms from excessive shade removal along streams can adversely affect Atlantic salmon survival by changing their feeding, reproductive, and migratory behavior, reducing suitable rearing habitat and available cold water refugia , and eliminating macroinvertebrate habitat	Increased enforcement and compliance monitoring of shoreland harvesting	Medium	High	DEP, LURC, if&w, mfs, wc, Project SHARE, municipalities	1997 and beyond	E. $20,000 (costs apply to 7 rivers)
	Educate logging contractors and resource managers to be sensitive to shading needs when planning tree harvesting in shoreland areas.	High	High	PROJECT SHARE, mfs	1997 and beyond	N $5,000 (costs apply to 7 rivers)
Forestry. Excessive woody debris blocking fish passage, restricting stream flow, and reducing dissolved oxygen	Remove blockages with advice from fisheries biologists	Low	High	WC, PROJECT SHARE, asa	ongoing	E
General Pesticide Use. Pesticide use has the potential to threaten Atlantic salmon if pesticides are present at levels that cause acute or chronic effects. Toxicity varies with chemicals	DEP, ASA, & BPC will review will review the geographic usage of pesticides in the seven watersheds and DEP will target areas for in-stream assessment.	Medium	High	DEP, bpc, asa	1998 - 2000	E
	The Board of Pesticide Control will work cooperatively with state agencies and the University of Maine Co-operative Extension Service to update best management practices based on the latest research and promote the use of these practices within the seven river watersheds.	Medium	High	BPC, state agencies, univ. of Maine	1997 ongoing	E
	The Board of Pesticide Control will respond to evidence of pesticides causing adverse environmental effects by proposing amendments to its regulations, updating best management practices, and changing product registration status where appropriate.	Medium	High	BPC	1997 ongoing	E
Recreational Angling. Incidental take associated with ATS angling	Severely limit catch and release fishery: restrictions on time (May 1-June 15, Sept. 15-Oct.		High	ASA	1997 - 1998	E. $3,500 (costs apply to 7 rivers)

	15), location (provide an upriver sanctuary for salmon), and gear (no nets, barbless hooks).	High				
Recreational Angling. Taking of juvenile Atlantic salmon by trout anglers who misidentify the species. Hooking mortality of juvenile Atlantic salmon caught incidentally by brook trout, landlocked salmon, and brown trout anglers.	Change fishing regulations in seven rivers and major tributaries (7/1-8/15) to: ALO minimum length on trout 8"; keep bag limit at 5; 7/1-9/30 current regulations but minimum length on trout is 8".	High	High	IF&W	1998	E
Recreational Angling. Adult Atlantic salmon are suseptable to angling in cold water holding areas.	Monitor cold water holding areas and close to all fishing as necessary.	High	High	IF&W	1997 and beyond	E
Recreational Angling. Hooking mortality of Atlantic salmon caught incidentally by anglers fishing for chain pickerel or bass.	The ALO regulation will minimize hooking mortality of any salmon that may be hooked by pickerel and bass anglers	Low	High	IF&W	1998	E
Recreational Angling. Potential of keeping an Atlantic salmon kelt taken in a lake by ice fishing as a "large trophy-sized Landlocked salmon or brown trout" resulting in the taking of an Atlantic salmon.	Promulgate new regulation establishing a 25" maximum size on Landlocked salmon in al of Washington County, except East Grand and West Grand Lakes.	Low	High	IF&W, dmr	1998	E. $3,500 total for all rule changes (costs apply to 7 rivers)
Illegal Fishing	Increase penalties for poaching	Medium	High	IF&W	1997	E
Illegal Fishing. Poaching of adult salmon	Staff all warden districts in the 7 drainage and hire 2 seasonal wardens. Assign top priority to prevention of poaching for wardens in districts where poaching is likely.	High	Medium	IF&W, asa, dmr	1997	N $20,120/year (cost applies to 7 rivers)
Commercial Fishing. Potential for incidental taking of ATS adults and juveniles in fyke and/or trap nets used by private citizens in early spring to capture common suckers for lobster bait in Atlantic salmon rivers and their tributaries	IF&W will not permit this activity in any locations having the potential to catch an Atlantic salmon.	Low	High	IF&W	Ongoing	E
Commercial Fishing. Potential for incidental taking of smolts and adult Atlantic salmon in elver fyke nets.	Monitoring of the fishery for Atlantic salmon by-catch will be ongoing. Recommend exclusion panels.	Low	High	DMR, asa	1997	E

Predation. Adverse effects of harbor seals on adult Atlantic salmon at mouth of rivers.	Study impacts of seals on Atlantic salmon.	High	High	DMR, maic	1997	to be determined
	Pursue control of seal populatons if warranted.	High	Low	DMR, maic		to be determined
Predation. Predation on Atlantic salmon smolts by double-crested cormorants.	Study impacts of cormorants on wild AT smolts.	High	High	IF&W, dmr,usfwn, nmfs, Universities	1997	N $50,000 over 2 years (cost applies to 7 rivers)
	Pursue control of commarant populations if warranted.	High	Medium	IF&W, dmr,usfwn, nmfs, Universities		to be determined
Wildlife Interactions. Populations of beavers in the 7 drainages have been increasing leading to serious limitations of Atlantic salmon ability to access upstream spawning areas as well as some degradation of Atlantic salmon habitat through impoundments and subsequent stream warming/siltation	Systematically remove key beaver dams with the assistance of Atlantic salmon and wildlife biologists.	High	High	WC, asa, Project SHARE	Ongoing	N. $3,000 (costs apply to 7 rivers)
Predation. Predation on Atlantic salmon by smallmouth bass inhabiting Atlantic salmon habitat	Promulgate new regulation; no size or bag limit on black bass.	High	High	IF&W	1998	E.
Predation. Predation on juvenile Atlantic salmon by American eels inhabiting Atlantic salmon nursery habitat	Sample gut contents of American eels captured which electrofishing juvenile salmon habitat to determine food habitats.	Currently unknown	High	ASA, ifw, university	1997 - 1998	E.
Contaminants. Release of toxic chemicals from waste storage facilities.	Conduct site evaluation and remedial clean-up at Super Fund Site.	High	Medium	EPA, usfws, dep	ongoing	E. $1.2 mil
	Conduct site evaluation and remedial clean-up at Smith Junk Yard.	High	Medium	DEP	ongoing	E. $5000

Entity Abbreviations:

ASA - Atlantic Salmon Authority, Maine
ASTF - Atlantic Salmon Task Force (Governor's), Maine
BPC - Board of Pesticide Control, Maine
CES - Cooperative Extension Service
DAFRR - Dept of Agriculture Food and Rural Resources, Maine
DEP - Department of Environmental Protection, Maine
DMR - Department of Marine Resources, Maine
SVCA - Sheepscot Valley Conservation Association
LWRC - Land & Water Resources Council, State Planning Office

IF&W - Inland Fish and Wildlife, Maine
LURC - Land Use Regulatory Commission, Maine
MAIS- Maine Aquaculture Inovation Center
MFS - Maine Forest Service
NRCS - Natural Resources Conservation Service, Federal
NMFS - National Marine Fisheries Service
SHARE - Salmon Habitat and River Enhancement, Project
SWCD - Soil and Water Conservation District, local
USFWS - United States Fish and Wildlife Service, Federal
WC - Watershed Council

C. Atlantic Salmon Conservation Plan Monitoring Schedule

Habitat Protection			
1) To further protect important in-stream Atlantic salmon habitat and adjacent riparian areas	a) complete habitat assessment and mapping work - use assessment as standard for measuring in-stream habitat over time		100 % of salmon habitat mapped by December 1997
	b) first option: identify landowners near significant Atlantic salmon habitat - negotiate agreements or conservation easements for long term protection of habitat with those landowners	% of significant habitat protected through landowner agreements or regulatory action	50% of significant habitat protected by December 1999 80% of significant habitat protected by December 2001
	c) second option: in the event that existing regulatory tools or land owner agreements are deemed inadequate, the Land & Water Resources Council will evaluate other regulatory protection measures (see river tables)		
2) To maintain current water quality standards and classifications (sufficient for salmon restoration)	a) promote the use of forestry, agriculture, and pesticide best management practices	% of industrial landowners in the watershed using BMPs	no reduction in water quality 80% of industrial landowners using BMPs by 1999; 90% by 2000; 100% by 2001
	b) conduct non-point source pollution education programs		
	c) implement Hexazinone State Management Plan	levels of hexazinone in rural domestic wells	progressive decrease in the number of wells with detectable levels of hexazinone progressive decrease in overall concentration of hexazinone in wells
	d) enforce existing standards for buffering activities near streams	number of shoreland zoning violations	80% of shoreland zoning violations corrected by December 1999 100% of shoreland zoning violations corrected by December 2001
	e) pursue conservation easements or acquisition of important riparian areas	% of significant habitat protected through landowner agreement or acquisition	50% of significant habitat protected by December 1999 80% of significant habitat protected by December 2001

3) Where appropriate, reduce non-point source pollution	a) assemble all water quality data available for each of the seven rivers	water quality data, by river, for pesticides, nutrients, and sediments	water quality data available by December 1998
	b) identify historic, current, or potential source and non-point source pollution problem areas	number of source and non-point source areas identified	all current and potential source and non-point source areas identified by December 1999
	c) develop strategies and action plans to minimize the impacts of identified pollution sources	number of plans in place	all corrective action plans in place by December 2000
	d) set up an ongoing water quality monitoring program on each river where appropriate	number of monitoring programs in place	all appropriate monitoring programs in place by December 2000
4)To ensure water withdrawal or impoundment does not adversely affect Atlantic salmon during low water periods	a) develop water management plans that account for Atlantic salmon water needs on the Pleasant, Narraguagus, and Machias Rivers	number of plans in place	All plans in place by December 1998 Habitat unaffected by water withdrawal or impoundment during periods of low flow conditions
	b) assess stream flow at significant habitat sites during dry periods using USGS stream discharge gauges and determine in-stream flow based on Atlantic salmon needs for rivers with irrigation or the potential for irrigation	number of in-stream flow determinations completed	All in-stream flow measurements and recommendations completed by December 1999
Habitat Enhancement			
5) To determine if significant habitat can be enhanced by augmenting water supply during periods of low flow	Examine the positive contribution of flow augmentation on Atlantic salmon when preparing the water management plans	amount of supplementary water needed and its temperature requirements for Atlantic salmon habitat enhancement	Conclude by December 1999 whether impoundments or other water sources would be useful in enhancing Atlantic salmon habitat Sites identified and plans completed by December 2001
6) To utilize local volunteers and landowners to create vegetative buffers where needed around significant habitat areas	a) identify significant habitat areas where improved vegetative cover is needed	surveys of significant Atlantic salmon habitat	Surveys completed by December 1998
	b) work with landowners to develop a plan to improve riparian areas where needed	plans in place to improve riparian areas	Plans completed for 50% of significant habitat by December 1999; 80% by December 2001
7) To utilize local volunteers to make prime habitat areas accessible to migrating salmon	a) systematically remove undesirable debris blockages and beaver dams	number of blockages and dams breached amount of increased habitat area accessible as a percent of total potential habitat	60% of potential habitat accessible by Dec. 1998; 80% by Dec. 2000; 90% by Dec. 2001

	b) encourage reduction of beaver populations	number of active beaver colonies	50% reduction in active beaver colonies on significant spawning habitat by December 2001
8) To protect, enhance, and restore high and moderate value wetlands	a) identify any degraded high and moderate value wetlands for restoration projects	number of wetlands identified	all degraded high and moderate value wetlands identified by 1998 50% of all identified wetlands included in restoration / enhancement projects by 2001
	b) identify the seven rivers as high priority areas for DEP compensation/mitigation banking projects	# of mitigation compensation/banking projects located in a river's watershed	
	c) identify high value wetlands that contribute to the maintenance of water quality	number of wetlands identified for special protection	All high value wetlands protected by December 2001
	d) ensure that all wetland permitting decisions take into account Atlantic salmon needs		no degradation of water quality due to wetland alteration
	e) continue education and compliance with current wetland regulations		
Species Protection			
9) To reduce harm to adult Atlantic salmon from legal angling	a) restrict catch and release fishery by setting limitations on time, location, and gear	% of Atlantic salmon killed due to angling	achieve <2% of fish caught that are killed by 1999
	b) require reports from anglers possessing salmon licenses on any Atlantic salmon catches, incidental or otherwise		
	c) institute an education program on proper fish handling	number of anglers receiving education	95% of all anglers handling fish properly by December 1999
10) To eliminate, to the extent possible, poaching of Atlantic salmon	a) increase warden activity in the seven watersheds	# of poaching incidents / enforcement effort	no increase in poaching activity as compared to 1997
	b) monitor key areas	intensity of enforcement activity	
11) To reduce the by-catch of salmon from riverine and coastal commercial fishing activities	a) require exclusion panels for all elver fyke nets	# of Atlantic salmon caught in fyke nets	no by-catch of Atlantic salmon by elver fishermen by December 1998

	b) prohibit sucker fishing for lobster bait in locations inhabited by adult and juvenile Atlantic salmon	# of commercial sucker fishermen operating in Atlantic salmon habitat	no commercial sucker fishing in Atlantic salmon habitat by December 1998
	c) monitor alewife fishery to determine if there is any incidental take of Atlantic salmon	# of Atlantic salmon caught by alewife fishermen	no by-catch of Atlantic salmon by alewife fishermen by December 1998
12) To reduce the incidental take of juvenile Atlantic salmon by recreational anglers	a) institute new angling regulations	conduct angler surveys to determine # of juvenile Atlantic salmon incidentally caught by anglers	50% reduction of mortality related to incidental take of Atlantic salmon by recreational anglers by December 2000 as compared to 1997
	b) angler education		
13) To understand the extent of natural predation of adult and juvenile Atlantic salmon in the rivers and estuaries	a) study the impact of seal and cormorant predation	# of Atlantic salmon taken by seals or cormorants	results of the study showing rates of predation
	b) study food habits of American eels to determine feeding habits and whether they are feeding on juvenile Atlantic salmon	# of juvenile Atlantic salmon taken by American eels	results of the study showing the amount of predation by American eels
14) To reduce the potential risks of pen raised fish interbreeding and competing with wild Atlantic salmon	a) installation of weirs	# of farmed fish spawning	elimination of farmed fish reaching spawning grounds by December 2001
	b) improve husbandry and harvesting practices throughout the aquaculture industry with the development of a Loss Control Code of Practices	% of operations using new Loss Control Code of Practices	100% of operations using new Loss Control Code of Practices by December 2000
	c) greater attention to preparing cages for storms and repair after storms	number of storm related insurance claims	progressive reduction in storm related escapees
15) To eliminate, to the extent possible, the escape of salmon from fresh water hatcheries	a) adopt loss control code of practices and follow up monitoring program	# of cultured salmon fry/parr captured below hatcheries	minimization of escapees from fresh water hatcheries by December 1998
16) To reduce the potential of disease transmission between farmed fish and wild Atlantic salmon	a) develop a Fish Health Code of Practices	# of incidences of disease	continue zero incidence of disease related transfer to wild stocks from fish culturing
	b) maintain all current fish health standards, protocols, and monitoring for Atlantic salmon at hatcheries and sea cages		
	c) continue brood stock and reproduction protocols that call for lethal sampling, testing of reproductive fluids, pair mating and tracking of egg lots, egg disinfection, and vaccination		
	d) vaccinate smolts against naturally occurring pathogens		

Fish Management			
17) To achieve target spawning escapement on each river	a) optimize smolt production	# of adults returning	50% of target spawning escapement of adults by December 2001
18) To achieve maximum smolt production commensurate with the habitat's production capacity	a) optimize fry production	# of smolts produced	100% of smolt production goal by December 2002
19) To fully utilize all available nursery habitat for salmon production	a) continue the program of brood stock collection and river specific rearing and stocking of fry	amount of nursery habitat occupied by fry and small parr	100% of available habitat utilized by juvenile Atlantic salmon by December 2000
20) To annually assess stocks of wild Atlantic salmon and accurately estimate populations in each of the seven rivers to allow adjustment to stocking requirements and management measures	a) enumerate returning spawners at each river's weir	number of returning, sexually mature, wild Atlantic salmon	adequate assessment of population of various Atlantic salmon ages classes
	b) continue to collect angler harvest data	number of adults caught by anglers	
	c) continue to perform annual redd counts for each river	number of redds	
	d) continue electrofishing to gather population estimates	number of 1st and 2nd year parr per sampling unit number of smolt produced	

D. Background on Biology, Management, and Historic Conservation of Atlantic Salmon

I. Biology of Maine Atlantic Salmon

The Atlantic salmon is an anadromous fish, which means that it spends most of its adult life in the ocean but returns to fresh water to spawn. Most adult salmon enter Maine rivers during the spring and early summer; however, fresh run or ***bright*** fish are common through early November. Bright salmon often have sea lice attached to their bodies, but these are usually harmless, dropping off within 48 hours after the fish have entered fresh water. As the fish mature sexually in the river, they become darker colored and mottled. By fall, they are almost bronze colored and often have large reddish spots on the head and body. Male salmon acquire the characteristic hook, or kype, on the tip of the lower jaw. The basic life cycle of Maine Atlantic salmon is illustrated in Figure 1.

Spawning in Maine takes place from mid-October through mid-November, depending upon water temperature and flows. Since early migrants spend up to five months in the river, deep, cool, well-shaded resting pools are needed to protect the salmon until they spawn.

Suitable spawning areas consist of coarse gravel or rubble in moving water so that sufficient oxygen is provided to incubating eggs. Salmon spawning areas are called ***redds***, and each redd consists of several ***egg pits*.** The female digs each egg pit by turning on her side and vigorously flapping her tail. The digging is accomplished by the water currents produced, rather than by actual body contact with the gravel. Frequent rest periods are taken between digging activities. The male, who usually mates with more than one female, spends his time courting the female or driving off other males.

When the egg pit is completed, the female settles into the depression, the male swims into position beside her, and some of the eggs and milt are deposited. Water currents in the egg pit mix the sperm and eggs to ensure efficient fertilization and hold the eggs in the depression until the female can cover them with gravel. Frequently, young male salmon (four to six inches long) are sexually mature and participate in the spawning act. Experiments have shown that these fish are just as capable of fertilizing eggs as adult salmon.

When spawning is completed in the first egg pit, the female moves upstream to dig another, and another, and so on, until all her eggs have been deposited. As each successive egg pit is made, the displaced gravel carries downstream to cover eggs in the pit below. The eggs are usually buried to a depth of five to eight inches but may be found as deep as 18 inches. When completed, the salmon redd may be up to 20 feet long and\or 20 feet wide, and containing as many as 8-10 egg pits.

The number of eggs deposited by a female salmon depends upon her size. A fecundity study utilizing salmon from the Machias and Narraguagus rivers revealed that the egg number per female ranged from 3,500 to nearly 19,000. Each female produced an average of about 800 eggs per pound of body weight, but this figure varied considerably with individual fish. A 10-pound female, therefore, could be expected to produce about 8,000 eggs.

Unlike the five species of Pacific salmon, the Atlantic does not necessarily die following spawning. The post-spawners, or ***kelts***, may return to the sea in the fall, but most overwinter in the river and return to the ocean the following April or early May. Having lost an average of 25-30 per cent of their body weight due to starvation (adult salmon do not feed in fresh water) and the rigors of migration and spawning, these thin, dark fish are also called ***black salmon*** or ***racers*** if caught by anglers in the spring. Most salmon that live to repeat the spawning cycle will spend 12-15 months in the ocean before returning to the river to spawn again, as long-absence repeat spawners although a few will reenter the river in the fall after only three to five months in the ocean as short-absence repeat spawners. Occasionally, a salmon will survive long enough to spawn three or four times and live to be eight to ten years old.

The eggs deposited in the fall usually hatch during March or April. The sac-fry, or ***alevins*** as they are called, are about one-half inch in length and have a large yolk sac protruding from their bellies. When the yolk sac is almost completely absorbed (in about six weeks), the young ***fry*** swim out of the gravel and begin feeding in the river.

Salmon first feed on plankton - microscopic plants and animals - but as they grow in size, their diet changes to insect larvae and insects. They also occasionally eat small fish such as alewives or minnows. As growth continues, the small salmon are called ***parr*** because of the eight to eleven dark, vertical bands (termed parr marks) on their sides. Salmon parr resemble small brook trout; however, unlike trout, they have black as well as red spots and a well-forked tail.

About 80 per cent of the parr in Maine streams remain in fresh water for two years, while the remaining 20 per cent stay for an additional year. Therefore, a salmon stream must provide extensive nursery areas where the young salmon can find sufficient food and protection from predators during this stage of its life history, since three year-classes of young salmon may occupy nursery areas at the same time.

Following two or three years of stream life, the time to leave fresh water approaches, and the salmon parr undergo several changes. Outwardly, the fish become thinner and the tail elongated and more deeply forked; the parr marks disappear as the fish turn very silvery. Inwardly, drastic changes occur to enable them to adapt to life in the sea. The salmon is now termed a ***smolt***, averages about seven inches in length, and migrates downstream to the ocean during May and early June.

As with all forms of life, the Atlantic salmon is subjected to various natural enemies. Fish that are known to prey on young salmon include chain pickerel, smallmouth bass, eels, and even larger brook trout, while birds such as mergansers, belted kingfishers, cormorants, gulls, and ospreys are known to eat small salmon. While in the ocean, salmon are subject to attack from seals, porpoises, and numerous larger species of fish. The mortality rate during life at sea is extremely high; for every 100 smolts that leave the river, only a fraction survive to return as adults.

Once in the ocean, salmon feed voraciously on other fish and crustaceans. Primary foods include herring, sand lance, capelin, and shrimp. As the salmon mature in the ocean, the life cycle is completed by a spawning migration back to fresh water. Most Atlantic salmon return to the river where they were spawned and reared.

Adult Atlantic salmon spend varying lengths of time in the ocean. Fish that spend one winter at sea are called ***grilse***, while older salmon are simply called ***salmon**.* Scientists refer to these fish as one sea-winter salmon (1SW) and multi sea-winter salmon (MSW), respectively. In any given year, grilse comprise less than 5% of the adult salmon returns to Maine rivers, with 2 sea-winter salmon providing most (85-95%) of the run and three sea-winter salmon and repeat spawners 2-5% of the run. The average adult Maine Atlantic salmon is from 28-32 inches in length and weighs from 8-12 pounds. The largest Atlantic salmon caught in recent years on rod and reel in Maine weighed more than 28 pounds; however, fish larger than 20 pounds are uncommon.

Tagging experiments have taken some of the mystery out of the ocean life of salmon. Until recent closures of commercial fisheries in the 1980's and 1990's, tag returns annually came from commercial fisheries in Nova Scotia, Newfoundland, Labrador, and Greenland - more than 2,500 miles from Maine. The Greenland area has been proven to be a common feeding ground for many European as well as North American salmon stocks. Using the length of time at sea between the time of release and time of recapture, movements of 10-15 miles per day have been calculated for Maine salmon --assuming straight line migration. Faster daily rates of migration probably occur, as random wandering must take place. Greenland tag returns from adult fish tagged in the rivers on their first spawning migration show that some Maine salmon make the 2,500 mile journey to Greenland more than once.

II. Management status and Maine laws protecting Atlantic salmon.

Effective September 29, 1995 the Maine Atlantic Salmon Authority (12MRSA, Part 12, Chapter 811) was established by the Maine legislature to manage the Atlantic salmon fishery in the state and to conduct and coordinate all projects involving research, planning, management, restoration or propagation of the Atlantic salmon.@ The ASA was established to replace the Atlantic Sea Run Salmon Commission which had been the states Atlantic salmon management agency for nearly 50 years.

Originally created by legislative statute in 1947, the Atlantic Sea Run Salmon Commission had been charged with the responsibility to restore and manage Atlantic salmon to all historical salmon rivers of the State. Specific powers which had been granted to the Commission were also granted to the Atlantic

Salmon Authority (' 9902) including the following: 1) sole authority and responsibility to manage the Atlantic salmon fishery in the state, including sole authority to introduce Atlantic salmon into Maine waters, limit the taking of salmon, issue licenses for the taking of Atlantic salmon and adopt rules establishing the time, place and manner of Atlantic salmon fishing in all waters of the state; 2) to conduct research, publish and disseminate information and plan reports, and implement programs as it deems necessary in furtherance of its purposes; 3) to enter into contracts, agreements or other arrangements with public agencies and with private parties; 4) to receive and expend funds from any source - public or private; 5) to adopt and amend regulations to promote the conservation and propagation of Atlantic salmon; 6) acquire, install, construct, operate, manage, sell and convey interests in real and personal property - including lands, dams, building, facilities, structures, flowage rights, mill privileges, easements, and rights-of-way.

The Authority is governed by the Atlantic Salmon Board, which consists of nine members including the current Commissioner of Marine Resources and the Commissioner of Inland Fisheries and Wildlife. The Governor appoints the remaining 7 members (subject to review by the joint standing Fisheries and Wildlife Committee of the legislature, and to confirmation by the Senate) as follows:

A. One member who resides within the land area comprising the Penobscot River or Ducktrap River drainage.

B. One member who resides within the land area comprising the Saco River or Sheepscot River drainage.

C. One member who resides in the Aroostook River drainage area.

D. One member who resides within those land areas that comprise the drainage for the St. Croix, Dennys, East Machias, Machias, Pleasant, or Narraguagus rivers.

E. One member of the Passamaquoddy Tribe.

F. One member of the Penobscot Nation.

G. One member at-large representing the public from a geographical area not specified above.

While the Atlantic Salmon Authority has no law enforcement capability, the rules and regulations promulgated by the Authority governing the taking of Atlantic salmon within the state are enforced by the Warden Service of the Department of Inland Fisheries and Wildlife in inland waters, and by the Marine Patrol of the Department of Marine Resources in coastal waters. Regulations pertaining to salmon may also be enforced by any Maine law enforcement officer.

A bilateral Cooperative Agreement between the Atlantic Sea Run Salmon Commission and the U.S. Fish and Wildlife Service (USFWS) which was renewed in 1990 remains in effect. The Agreement delineates the duties and responsibilities of the two agencies and establishes a Technical Advisory Committee (TAC). The TAC is composed of four members assigned by the Authority, four members assigned by the U.S. Fish and Wildlife Service, and one member assigned by the Penobscot Indian Nation. The purpose of the TAC is to advise the Authority and the U.S. Fish and Wildlife Service on technical matters relative to the Atlantic salmon restoration program in Maine, to review and comment on proposals for cooperative research, and to provide assistance in developing and updating salmon restoration plans.

III. Historical Efforts to Protect Maine Atlantic Salmon Populations.

Atlantic salmon stocks were historically found in at least 34 rivers and streams in Maine (Rounsefell and Bond, 1948). While the size of individual salmon runs in Maine is open to speculation, existing information about available habitat and historical commercial catches indicates that total adult returns to Maine prior to the 19th Century may have been as high as 500,000 fish. As with all forms of animal life, Atlantic salmon populations undoubtedly fluctuated greatly from year to year depending upon various natural factors. By the mid-1800's many Maine rivers had already lost their salmon runs and others were substantially diminished. The most commonly cited reason for declining Atlantic salmon runs in the 1800's was the construction of numerous and formidable dams which were complete barriers to migrating fish.

Additional factors cited as contributing to declining runs were water pollution, excessive commercial netting, and predation.

Early attempts to halt the decline in Atlantic salmon runs focused upon the construction of upstream fishways, restricting commercial netting operations, and the stocking of hatchery-reared fry. Unfortunately, fish passage facilities were often poorly designed, improperly located, or inadequately maintained. In some instances, exemptions were also granted to dam owners who couldn't=t afford to install fishways. Attempts to restrict catches were hindered by a lack of enforcement capability and widespread poaching problems. Although millions of hatchery-reared salmon fry were released into Maine rivers, adult returns continued to dwindle as fish passage and water quality problems increased in severity throughout the 20th Century. Additionally, the introduction of several non-native species of fish into Maine rivers during the 1800's negatively impacted Atlantic salmon populations. Introduced species such as smallmouth bass, chain pickerel, and brown trout have been documented to prey upon juvenile Atlantic salmon, thereby reducing the productivity of Maine salmon streams compared to similar streams in the northern portions of the salmon=s range (for example, Quebec and Newfoundland).

Frustrated by a lack of success in halting the decline of Maine Atlantic salmon runs, fish culturists made unsuccessful attempts to introduce many non-native species such as Pacific salmon, steelhead, grayling and Scottish sea trout (brown trout). During the period of 1902-1926 more than 25 million of these fish were stocked throughout Maine. Attempts to introduce Canadian Atlantic salmon stocks from New Brunswick and Quebec into Maine rivers also failed.

In 1945 the Governor of Maine appointed a three-person Commission to study the status of the remaining Atlantic salmon resource with a mandate to report back to the next session of the legislature. In its report, the Governor=s Commission recommended the creation of a single administrative unit (the ASRSC) within state government with authority over salmon in both fresh and salt water.

Some of the key management activities undertaken by the Atlantic Sea Run Salmon Commission and its staff during the period of 1947-1995 included habitat surveys and habitat improvement measures, fish passage improvements at natural and human-made barriers, water level control programs, the elimination of commercial fishing, progressively restrictive sport fishing regulations, and various stocking programs utilizing hatchery-reared, Maine-origin stocks. The Commission staffs= research activities have focused upon Maine Atlantic salmon life history data and population monitoring studies which are crucial to restoration and management programs. Operation of a year-round counting fence on the Narraguagus River, continually from 1959-1966 and seasonally to 1969, provided a wealth of knowledge about the parr, smolt and adult life stages of Maine Atlantic salmon. Additional important research initiatives have included studies to evaluate stocking methods and practices, predation studies and tagging studies (both smolts and adults) which documented the marine migrations and exploitation of Maine salmon stocks in the commercial fisheries of Canada and Greenland.

The Atlantic Sea Run Salmon Commission=s 25-year Carlin tagging database was instrumental in demonstrating to NASCO that Maine-origin salmon stocks were being subjected to average annual exploitation rates estimated by the ICES North Atlantic Salmon Working Group to range from 40-60% for 1SW salmon and 70-90% for 2SW salmon (Anon., 1993).

The increased production of hatchery-reared salmon , in addition to improved water quality and new or improved fish passage facilities, dramatically increased Maine salmon runs and sport fisheries during the 1970's and 1980's. In fact, the sport catch of Atlantic salmon during the 1980's was three to five times greater than during any other decade in Maine history. (Baum 1995). Significantly, due to restrictive management measures and changing angler ethics, more than two-thirds of the salmon caught in the sport fishery in recent years were released.

Since the creation of the Atlantic Sea Run Salmon Commission, the amount of habitat accessible to Atlantic salmon in Maine has shown a tenfold increase. Total salmon returns to the state also increased similarly by the mid-1980's. However, that trend has been reversed as the return of wild-origin salmon has also exhibited a similar declining trend. Releases of hatchery-reared fish and documented Atlantic salmon returns to Maine rivers since 1970 are illustrated in Figures 2 and 3. Comparable reductions in marine smolt survival and adult salmon abundance have been demonstrated in other North American salmon stocks (e.g., other New England and Canadian rivers which drain into the Gulf of Maine).

The overall decline in the abundance of North American Atlantic salmon stocks was the primary reason for the closure of the Newfoundland commercial fishery in 1992 and the Greenland commercial fishery in 1993 and 1994. There is general agreement among fishery scientists that this recent period of low marine survival during the first winter at sea is negatively impacting Atlantic salmon stocks over a broad geographical area. This may be a natural, cyclical phenomenon or it may be a consequence of human activities (e.g., global warming).

Maine Atlantic salmon populations have declined dramatically since the mid 1980's. The Atlantic Salmon Authority has documented this decline through long-term angling catch data, counts of adult salmon, redd counts, and juvenile population assessments conducted through electrofishing surveys (Baum 1995).

IV. Current Maine Atlantic Salmon Restoration Goal and Management Objectives

Maine's current statewide Atlantic salmon restoration goal (from Baum 1995) is as follows:

To protect, conserve, restore and enhance Atlantic salmon habitat and populations within historical habitat in Maine.

Although numerous Maine rivers once contained naturally-reproducing salmon populations, the limited financial and personnel resources available currently limit the statewide salmon restoration program to the following 16 rivers: Androscoggin, Aroostook, Dennys, Ducktrap, East Machias, Kennebec, Machias, Meduxnekeag, Narraguagus, Penobscot, Pleasant, Prestile, Saco, St. Croix, Sheepscot, and Union (Figure 1). The population status and estimated smolt production potential for all salmon rivers in Maine are shown in Table 1. The Atlantic salmon stocks in the seven rivers (Figure 5) which are included in Table 1 have been, and will continue to be, the state=s highest priority. Therefore, the protection and conservation of salmon habitat and populations in these rivers is the primary purpose of this Conservation Plan.

Table 1. Restoration and population status, estimated amount of juvenile habitat, and production potential in present and former Maine Atlantic salmon rivers. (See notes at bottom of page for explanation of terms used).

The following management objectives for the statewide Atlantic salmon restoration and management program were adopted by the Atlantic Sea Run Salmon Commission in September, 1995; the Atlantic Salmon Authority is expected to adopt these or similar management objectives in the near future:

1. To restore and manage existing Atlantic salmon habitat and populations.

2. To define and characterize the genetic integrity and diversity of existing Maine Atlantic salmon stocks for the purposes of restoration and restocking programs.

3. To increase natural reproduction in order to fully utilize the available Atlantic salmon habitat.

4. To provide recreational angling opportunities and compatible non-consumptive uses of Maine's Atlantic salmon resource.

5. To improve the survival and contribution to future salmon runs from the use of hatchery-reared stocks in Maine restoration and management programs.

6. To improve upstream and downstream fish passage for Atlantic salmon where there are natural and artificial barriers to migration.

7. To increase public awareness and broaden support for attainment of the Commission's overall goal.

8. To comply with applicable state, federal and international laws which may be applied to the Maine Atlantic salmon restoration program.

9. To coordinate Maine Atlantic salmon restoration and management activities with all other state, federal, private, and where applicable, Canadian entities, in order to achieve the Commission's goals.

10. To establish reciprocal, positive relationships with Maine's farm raised Atlantic salmon industry.

11. To support private and international restoration efforts and programs that comply with and augment the goal and objectives delineated in this plan.

The current management goals for the seven rivers which are the focus of the proposed federal listing action are shown in Table 2 .

Table 2. Atlantic salmon management goals for the seven rivers.

Since 1992, the overall management strategy adopted by the Atlantic Sea Run Salmon Commission and the USFWS for the Maine Atlantic salmon program is to maximize production of wild Atlantic salmon smolts by restocking with river-specific stocks, with an emphasis upon fry releases. The goal for each of the seven rivers is to rebuild naturally-reproducing Atlantic salmon populations to levels where stocking will no longer be necessary on a continual basis. From a fisheries restoration and management perspective, these efforts will influence the Maine Atlantic salmon restoration program well into the 21st Century, since a long-term commitment is required to develop the necessary stocks, and several generations of adult returns will be required to rebuild Atlantic salmon populations.

V. On-going Cooperative Atlantic Salmon Restoration Efforts in Maine.

The restoration and rehabilitation of Atlantic salmon runs on the seven rivers in Maine involves long-standing, complex working relationships and partnerships among numerous state and federal agencies and private sector groups. While the Atlantic Salmon Authority is the lead salmon restoration agency in Maine, the ASA maintains a close working relationship with numerous other state agencies, such as the Departments of Inland Fisheries and Wildlife, Marine Resources, Environmental Protection, Conservation, etc. On the federal level, the Atlantic Salmon Authority and its staff work closely on a daily basis with U.S. Fish and Wildlife Service and National Marine Fisheries Service personnel. Close working relationships are also maintained between the Atlantic Salmon Authority and numerous Maine salmon angling clubs and salmon conservation organizations, such as the Atlantic Salmon Federation and Project SHARE.

In 1992, the State of Maine through the ASRSC and the U.S. Fish and Wildlife Service implemented a river-specific stocking program for the seven rivers. The basis for this program (Baum et al. 1992) was based upon the following events:

(1) Declining Atlantic salmon populations (despite increased stocking with hatchery fish of Penobscot River origin) in the seven rivers.

(2) Category 2 listing under the Endangered Species Act of 5 of those rivers by the USFWS in November of 1991.

(3) Conversion of the Craig Brook National Fish Hatchery from a single broodstock/smolt production facility to a multiple broodstock/fry production facility.

(4) A wealth of information in the fisheries literature (from both North America and Europe) which indicates that restocking efforts are most likely to be successful when the donor population comes from the river to be stocked.

The ASRSC and USFWS adopted a long-term planning process because of the possibility that unique, river-specific Atlantic salmon socks may still exist in Maine which may need the protection of the State of Maine or the Federal Endangered Species Acts. Whether or not there are any remaining wild stocks in Maine that qualify for State or Federal protection is currently unknown and cannot be determined without many more years of data collection at considerable expense. Until it can be shown that such stocks exist, the salmon populations in the seven rivers will continue to be managed as genetically viable and distinct stocks.

The origin of individual Atlantic salmon cannot reliably be determined by externally visible characteristics; therefore, the 1992 plan adopted by the ASRSC and the USFWS addressed a group of salmon that is collectively referred to as a "stock". At that time a "wild" stock was defined as a reproductively isolated, river-specific salmon population that is: (a) native or indigenous to Maine, (b) different from hatchery (or cultured) stocks, and (c) different from other wild stocks, (Baum et al. 1992). These differences may be detectable in the following categories:

1. Genetically-based differences (detected by protein electrophoresis, DNA fingerprinting, or similar procedures),

2. Habitat-based differences (river-specific adaptations due to habitat or environment, including ocean life),

3. Phenotypic differences (fish size, body form, disease resistance, etc.),

4. Life history differences (run timing, age at maturity, migration patterns, etc.).

The management strategy to advance the recovery of these stocks included plans for adult and juvenile salmon stock assessment, habitat inventory, and procurement of river-specific broodstock for the fry stocking program. In an effort to increase the adaptability and survival of stocked fry, and to protect the genetic integrity of existing salmon stocks, the seven rivers are only stocked with the progeny of river-specific broodstock (broodstock obtained from within that same river). The paucity of wild adult salmon for use as river-specific broodstock in recent years has created the need to collect wild salmon parr from the individual rivers and rear them to sexual maturity in captivity at Federal hatcheries. The exact number of parr collected varies among years and rivers, depending on anticipated needs, parr availability, and other factors. Acquisition and development of river-specific broodstocks for the rivers has resulted in the collection of 90 adult sea run salmon from three rivers and nearly 5,000 wild salmon parr from six rivers for the river-specific broodstock production program. These broodstock sources have produced more than 2.1 million eggs to date, resulting in the stocking of more than 1.2 million fry (see Table 3) and 2,000 smolts in five of the rivers. The number of fry available for stocking in future years is expected to increase substantially on an annual basis, resulting in a sufficient supply to saturate all available habitat with high quality, river-specific fry in the near future.

Table 3. River specific fry stocking in seven Maine rivers

Year	Dennys	E. Machias	Machias	Pleasant	Narraguagus	Sheepscot	TOTAL
1992			13,790				13,790
1993	32,700						32,700
1994	19,960		49,970				69,930
1995	84,000		150,000		105,000		339,000
1996	141,600	114,880	232,870		196,230	102,390	787,970
1997[1]	212,400	131,400	247,800		216,000	124,200	931,800
1998-2002[2]	220,000	130,000	320,000	100,000	260,000	110,000	1,140,000

[1] - based on 1996 egg collection
[2] - production goals

As a result of the extensive fry stocking which occurred in 1995 and 1996, along with a limited amount of natural spawning, the Atlantic salmon nursery habitat in the Dennys, Machias, and Narraguagus Rivers is approaching full production. Recently, Congress appropriated $4.8 million for the completion of Phase I of the Craig Brook improvements. This will help to ensure that adequate facilities will be available for the production of river-specific fry in the future. Juvenile salmon populations will, however, continue to be monitored annually to evaluate the results of fry stocking efforts and to document the extent of habitat utilization in all seven rivers.

Since 1992, portable weirs have been seasonally operated on the Dennys, Pleasant, and Sheepscot rivers to enumerate adult returns, to collect sea run broodstock, and to obtain biological data from individual salmon. Additionally, field trials of an experimental floating weir, based on a design currently in use in Alaska, have been conducted on the Dennys River in 1995-1996. Presently, Project SHARE is building a new trap which will attract salmon and aid biologists in collecting and handling fish. The floating weir was designed to help alleviate some of the perpetual problems associated with the picket style weirs. In 1996 the weir withstood flood conditions with little damage. A permanent salmon trapping facility has also been operated by the Atlantic Salmon Authority on the Narraguagus River since 1991, with funding for this operation provided by a grant from the NMFS. Total adult salmon returns to all of the seven rivers are estimated annually by quantifying spawning activity (i.e., redd counts).

Historically, angler harvest data have been used in Maine as an indicator of adult salmon abundance. However, as salmon runs and fisheries declined in recent years, the State of Maine employed numerous new, increasingly-restrictive, sport fishing regulations in order to reduce the harvest of MSW salmon in the seven rivers. Finally, in direct response to the continued decline in adult salmon returns to Maine rivers, on June 7, 1995 a new regulation was promulgated by the Atlantic Sea Run Salmon Commission prohibiting the harvest of any Atlantic salmon in Maine waters.

Knowledge of the quantity and quality of Atlantic salmon habitat in the seven rivers is necessary for effective management of the Atlantic salmon populations in those rivers. Since 1992 the Atlantic Salmon Authority and USFWS have devoted a large portion of each field season to the completion of intensive juvenile salmon habitat inventories in the seven rivers. For example, over 100 km. of the Machias River drainage was surveyed in 1995 using an advanced Geographic Positioning System. Highly accurate computerized habitat data sets are now available for most of the seven rivers. These data will be used to develop landowner agreements to protect significant salmon habitat or to designate the habitat for protection under Maine=s Natural Resource Protection Act, and to coordinate future redd counting, parr collecting, and fry stocking activities.

In 1995 and 1996, water temperatures were monitored with 29 continuous recording thermograph units, provided, in part, by Project SHARE and deployed throughout six of the seven rivers. Data retrieved from these units during low flow periods in 1995 indicate that ambient river temperatures were frequently above suitable levels for salmon, particularly on the East Machias, Dennys, and Sheepscot rivers. These date illustrate the importance of identifying and protecting the cold water refugia which are vital to Atlantic salmon growth and survival. Both the Agriculture and Forestry sections of this plan detail the sources of elevated water temperatures and outline the measures for addressing stream temperature increases where necessary.

Beaver dams and debris jams have been a perennial problem on Maine rivers, often preventing salmon access to some of the best spawning habitat. Surveys to locate these obstructions are conducted on all seven rivers on an annual basis. It is often necessary to repeat the task of breaching these obstruction in order to provide an adequate migration window for salmon.

An intense interest concerning the genetic characterization of Maine Atlantic salmon stocks has developed in recent years. Genetic sampling programs were initiated in Maine during 1990, but results to date have been inconclusive due to the sampling and analytical procedures utilized. An intensive three-year study designed by the Leetown Science Center is focusing on developing laboratory techniques to accurately assess genetic differences between rivers and genetic consistencies between year classes. ASA and USFWS personnel collected samples of genetic material from salmon in several rivers in 1994, 1995, and 1996.

The State of Maine will continue to rely upon an integrated and coordinated approach with other public and private entities for the maximum benefit of the resource. Of special importance will be the continued close working relations between ASA and U.S. FWS personnel in the ongoing rehabilitation programs for the seven rivers. Priority projects include:

1. Completion of the habitat inventory of all mainstems and important tributaries and preparation of associated maps. The habitat inventory and mapping has been an intensive three year project. Although most of the mapping is now complete, there are short sections of several rivers that need to be surveyed or rechecked. This should be completed in 1997 and maps available to initiate landowner contacts shortly thereafter.

2. Increase juvenile population assessments. Fry stocking is a major population enhancement measure for the seven rivers and its evaluation is critical to the restoration effort. Now that the habitat inventory and mapping is nearing completion, juvenile population assessment will be a top priority.

3. Weir operation. As funds become available weir construction and operation will be central to the program. Currently weirs are in operation on the Dennys and Narraguagus and seasonally on the Sheepscot Rivers. Weirs are important for broodstock collection, monitoring the adult runs and excluding unwanted fish. Priority will be given to the East Machias, Machias and Pleasant rivers in that order.

4. Evaluation of natural production. Extensive redd counts will continue in order to evaluate natural production and obtain estimates of adult runs.

5. Other activities will include removal of obstructions to migration, initiation of landowner contacts, volunteer coordination, public education and outreach.

6. Finally, the ASA will continue to work closely with NMFS personnel in identifying and quantifying the causes of the observed declines in the salmon runs to the seven rivers. The initial 5-year study (1990-1994) concentrated on the Narraguagus River and revealed that the decline of the salmon run was largely attributable to marine, not freshwater causes. The second 5 year study is focusing upon the estuarine and early marine phases of the salmon's life cycle and involves determining smolt production and survival.

Results from the studies referred to above are available in reports which are prepared annually by the Atlantic Salmon Authority and U.S. Fish and Wildlife Service (see: Atlantic Salmon Authority/U.S. Fish and Wildlife Service 1996; Beland, et al. 1995; Horton, et al. 1996; US Fish and Wildlife Service/Atlantic Sea Run Salmon Commission 1995).

VI. New Atlantic Salmon Restoration Initiatives

Several new Atlantic salmon restoration/rehabilitation initiatives are described in greater detail in later sections of this Conservation Plan. Initiatives with the agriculture, aquaculture, forestry, and recreational fishing interests are expected to contribute significantly to the protection of Atlantic salmon habitat, and the enhancement of adult salmon runs and spawning escapement in the seven rivers in future years. For example, a water-use inventory and management plan for the Narraguagus and Pleasant Rivers was completed in July of 1996. Additionally, an agricultural land use inventory for the Sheepscot River was finished in the summer of 1996. The State of Maine and conservationists in the Sheepscot and Ducktrap Rivers watersheds are currently protecting and restoring important wetlands through acquisition, conservation easements, and management. These actions are particularly noteworthy because the wetlands contribute to water quality in each river.

Finally, 30,000 Atlantic salmon eggs (10,000 each from the Dennys, Machias and Narraguagus River broodstock at Craig Brook National Fish Hatchery) were transferred to two commercial hatcheries in Maine. The Maine aquaculture industry has volunteered to rear these stocks to the smolt stage in 1997. Some smolts will be transferred to salmon farms in eastern Maine where they will be reared to maturity, while the balance will be stocked into their respective rivers of origin.The objective of this river-specific stock rehabilitation program is to provide for adequate spawning escapement in the three rivers. Adult returns from smolts released into the three rivers in 1997/1998 and those held for pen rearing are expected to be available in the summer of 1999-2000.

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E. Education and Outreach Program

I. Purpose

The purpose of the Education and Outreach Program is to ensure that the general public and other targeted groups are informed and supportive of the programs to conserve Atlantic salmon, and to provide meaningful opportunities for these same groups to become actively involved in and contribute to salmon conservation efforts on the seven affected Maine rivers. The rationale behind this stated purpose is that healthy anadromous rivers and Atlantic salmon populations yield broad ecological, cultural, and economic benefits to the general public (not just specific user groups, such as anglers), and that the overall success of specific conservation programs proposed by the Atlantic Salmon Task Force in this Conservation Plan will depend in part on the additional resources represented within the private sector.

Direct and indirect negative impacts on the species and its habitat (i.e. "take") can result from inadvertent or intentional noncompliance with land use or other regulations (e.g. urban development, forestry, agriculture, aquaculture) and angling restrictions (e.g. poaching), or specific actions intended to remove political or financial support for conservation efforts. Indirect negative impacts can result from lack of public involvement in specific salmon conservation programs. Public involvement can include, but is not limited to: providing in-kind services to assist under-funded and under-staffed state and federal agencies, and providing funds through private conservation entities, both of which will be vital to implement all conservation programs proposed in the Conservation Plan.

The Education and Outreach Plan will address recreational fisheries issues, forestry issues, agricultural issues, and aquaculture issues.

Target audiences and participants include the general public, user groups, resource management groups, and municipalities. Education and outreach efforts will be designed to inform and "train" practitioners with respect to modified or improved techniques (e.g. best management practices) that will yield a net conservation benefit for Atlantic salmon. In addition, education and outreach programs will specifically address training non-technical volunteers to provide general assistance in Atlantic salmon assessment, enhancement, enforcement, and monitoring activities.

The Education and Outreach Program will include:

A. Conservation Plan Summary for general distribution, including public forums.

Target:	General public
Responsible Entity:	Governor's Office, ASA, MDIFW
Cost:	$2,000
Fund Source:	General Fund, Special Revenue accounts
Intent:	General information about process, what the conservation plan will achieve and how it has involved all sectors in its development, and how impact of salmon conservation efforts will mesh with existing business, industry, and other pastimes in the region.

B. Atlantic Salmon Education Center

Target:	General Public
Responsible Entity:	Private Groups in cooperation with ASA
Cost:	1st Year: $52,000; subsequent annual costs: $30,000

Fund Source: Private (corporate, foundations)

Intent: Target general public, school children, recreational anglers, outdoor recreationists. Specific information about salmon biology, life history, habitat requirements, threats, and remedies to threats; also ecological and economic benefits of healthy salmon populations. Costs include one-time costs to complete facility, plus ongoing annual operating costs, including rent, utilities, etc., part time staff, community outreach programs (e.g. ASF's Fish Friends educational curriculum), education materials, and local workshops.

C. RiverKeep Program

Target: A coordinated watershed network of trained local anglers, conservationists and other citizens who will assist in enforcement, assessment, enhancement, and monitoring activities.

Responsible Entity: MDIFW, ASA, Private Groups

Cost: $15,000 annually

Fund source: Private (corporate, foundation), State agency in-kind

Intent: Establish watershed conservation groups targeting local anglers, other interested citizens, who will be trained in specific areas of enforcement, assessment, enhancement, and monitoring. Result will be a trained volunteer network throughout watersheds to assist under-funded and under-staffed federal and state agencies implement conservation programs for salmon. Costs include training, travel and expenses for Volunteer Coordinators for each watershed, and printed and other materials.

D. Catch and Release Educational Campaign

Target: All anglers in the seven-river regions, as well as other salmon rivers, with emphasis on salmon and trout anglers.

Responsible Entity: ASA, Private

Cost: $5,000 annually

Fund Source: Private (corporate, foundation), State, Federal, and Private in-kind

Intent: Catch and release angling, when properly conducted, can result in no or extremely low mortality for angled fish. The campaign will detail specific methods to maximize survival of angled salmon, and provide the rationale behind the need to strict compliance. Costs include printed materials, distribution costs, streamside workshops, etc.

E. Best Management Practices Technical Assistance Materials

Target: This is a multi-faceted program directed at practitioners in the forestry, agriculture, or aquaculture industry, and private, non-industrial landowners/managers.

Responsible Entity:	ASA in cooperation with Maine Departments of Environmental Protection, Conservation, Agriculture, Marine Resources, and Land Use Regulation Commission. Also cooperate with private conservation groups for delivery/funding.
Costs:	$25,000 for 2 years; $5,000 thereafter.
Fund Source:	Federal funds, Private grants, State and/or Federal agency in-kind
Intent:	Develop and disseminate ongoing programs to educate land mangers and natural resource users about the importance of Atlantic salmon, land- and water-based threats to salmon survival, and best management practices to mitigate/eliminate threats. Program will include a local monitoring component (e.g. RiverKeep) in coordination with state agencies and municipalities to enhance enforcement and compliance activities within each watershed. Specific attention will be given to involving local municipalities especially through enhanced contact with state agencies in developing BMP's and in delivering technical assistance materials.

Topic areas:

Forestry:

1) Using the information on significant Atlantic salmon habitat developed by the ASA, the Maine DEP and the code enforcement program will conduct workshops with municipal officials to alert them to the importance of these areas and encourage them to adjust their shoreland zoning accordingly. Perhaps contract with regional planning councils to do this work.

2) The Maine Forest Service, Project SHARE, and the Mid-Coast Atlantic Salmon Watershed Council (MCASWC) will develop and implement a series of workshops aimed at improving logging and road construction contractor's practices in the 7 watersheds and to alert them to the existence and importance of significant Atlantic salmon habitat.

3) Project SHARE and MCASWC will sponsor volunteer monitoring programs in the 7 river watersheds and hold a series of training sessions designed to educate the RiverKeep volunteers on what to look for and how to identify, document, and report problems. State agencies and municipalities should also be a part of this component as they will be alerted when a problem is discovered.

4) Each of the above will require the development of written and visual materials.

Agriculture: Programs similar to those described for forestry in the preceding section will address without limitation point- and non-point-source pollution abatement and prevention; water removal; peat mining effects; and pesticide management (see Agriculture section or detailed discussion).

Aquaculture: Education and outreach efforts will include informing the public about the aquaculture industry generally, including tours, symposia, and printed materials. Special emphasis will be given to specific cooperative programs such as the pen-rearing programs for river-specific stock enhancement.

F. Enforcement

In most cases, state agencies currently have adequate personnel to enforce most of the activities considered in this Plan. For example, LURC currently licenses pump sites and water withdrawal in unorganized towns while DEP deals with sites under NRPA. DEP also licenses all discharges into public waters. Both Agriculture and DEP enforce non-point source pollution associated with agricultural activities, while the Board of LURC or DEP oversee the development of peat mining. There is a concerted educational effort to institute BMPs throughout the agricultural community.

The major issue in forestry is oversight of shoreland timber harvesting. Both MFS, DEP and LURC are involved in monitoring and enforcement of this activity.

All siting, developing and operation of finfish aquaculture facilities within the state come under the egis of DMR. Both DMR and IF&W enforce fish health regulations.

Regulation of recreational fishing is done primarily by IF&W with DMR regulating fishing in tidal waters. There is need to add two seasonal wardens downeast to enforce the proposed salmon regulations. Annual cost is approximately $36,000. Special training sessions will be held for IF&W and DMR Wardens to increase their knowledge of the Conservation Plan and the enforcement issues. As appropriate, similar sessions will be held for enforcement personnel in other state agencies.

On each river, watershed conservation groups (River Keepers) will be mobilized to monitor state regulations and report potential violations of state laws to the appropriate authorities. They will be the "eyes and ears" for each river.

In summary, we propose an integrated approach to enforcement enlisting public support for general oversight of activities throughout each watershed coupled with a well trained, informed enforcement detail from the various state agencies to resolve specific issues.

G. Agriculture

Introduction

The National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS) have proposed listing the Atlantic Salmon in seven Maine rivers as threatened under the Endangered Species Act (ESA) based on their status review. In these watersheds, agriculture includes a complex list of activities directed at producing crops and animals, or their by-products for human use. A list of the types of agricultural activities and/or products in these watersheds include: dairy farming, hay, silage corn, horse farming, sheep farming, beef cattle, Christmas trees, market vegetables, blueberries, cranberries, landscape and horticultural plants, and peat mining. Farmers use and maintain a wide variety of pieces of equipment appropriate for different tasks. Agricultural production can be grouped into three major categories, listed below along with associated activities:

1. Crop production and animal husbandry: site preparation, tillage, cultivation, manure, nutrient, and pest management, and water use.

2. Harvest and transport: public and farm road construction and maintenance, buildings, storage, fuel storage, and water for wet harvest of cranberries.

3. Processing and marketing: pest management, process water use, treatment, and discharge, waste recycling and disposal, buildings, and transport to market.

In preparing this section of the Conservation Plan, activities that had similar effects on stream hydrology and water quality were grouped. As a result there are three issues addressed in this report; Water Use, Agricultural Practices, and Peat Mining. Within the Water Use section, irrigation and use and disposal of process water are discussed. The Agricultural Practices section includes most of the activities involved with crop production and harvest and transport that may cause nonpoint source pollution. Direct discharge from agricultural processing plants are also included. Peat mining, because the product is used primarily for agriculture, is the third section. It warranted a separate section because the effects on stream hydrology and water quality were very different.

In each section of this portion of the Conservation Plan there is a brief discussion of the approach to estimating threat. None of the activities covered by this portion of the plan are anticipated to cause direct mortality to Atlantic salmon. Some activities do, however, have the potential to drastically affect the quantity and quality of Atlantic salmon habitat. Therefore, the focus is on assessing the threat from agriculture to Atlantic salmon habitat.

Each agricultural activity that could pose a threat to Atlantic Salmon habitat was prioritized by the Agricultural Working Group for each watershed (Tables 1.1-1.7). Specific actions to reduce threats and promote recovery are identified and schedules for implementing these actions are included for each watershed.

The key to creatively and successfully providing for the needs of both agriculture and Atlantic salmon is watershed planning. Actions appropriate for a given watershed will be identified and implemented by watershed-specific steering committees, which include all interested stakeholders. These steering committees will direct Atlantic salmon conservation activities and projects related to agriculture within each watershed. This model can be broadened to include implementing actions for other land use issues in Atlantic salmon watersheds.

Table 1.1. Potential threats to Atlantic salmon habitat quantity and quality related to agricultural activities in the Pleasant River watershed.

WATERSHED: PLEASANT RIVER		
AGRICULTURAL ACTIVITY	**FACTOR POSING A POTENTIAL THREAT TO HABITAT**	**ISSUE PRIORITY**
Water Use	Irrigation	High
	Cranberry culture	Low
Agricultural Practices	Pesticide use (blueberry, cranberry)	Moderate
	Nutrients and sediments	Low
	Wetland alteration	Low
	Oil, fuel, and contaminants	Low
Peat Mining	Proposed mine	Moderate

Table 1.2. Potential threats to Atlantic salmon habitat quantity and quality related to agricultural activities in the Narraguagus River watershed.

WATERSHED: NARRAGUAGUS RIVER		
AGRICULTURAL ACTIVITY	**FACTOR POSING A POTENTIAL THREAT TO HABITAT**	**ISSUE PRIORITY**
Water Use	Irrigation	Moderate
	Process water Volume Temperature	Low
	Land application of process water	Low
Agricultural Practices	Pesticide use (blueberry)	Moderate
	Nutrients and sediments	Low
	Wetlands alteration	Low
	Oil, fuel, and contaminants	Low

Peat Mining	Water quantity	Moderate
	Peat silt	Moderate
	Discharge water quality pH	Moderate

Table 1.3. Potential threats to Atlantic salmon habitat quantity and quality related to agricultural activities in the Machias River watershed.

WATERSHED: MACHIAS RIVER		
AGRICULTURAL ACTIVITY	**FACTOR POSING A POTENTIAL THREAT TO HABITAT**	**ISSUE PRIORITY**
Water Use	Irrigation	Low
	Process water Volume Temperature	Low
Agricultural Practices	Pesticide use (blueberry)	Moderate
	Nutrients and sediments	Low
	Wetlands alteration	Low
	Oil, fuel, and contaminants	Low

Table 1.4. Potential threats to Atlantic salmon habitat quantity and quality related to agricultural activities in the Sheepscot River watershed.

WATERSHED: SHEEPSCOT RIVER		
AGRICULTURAL ACTIVITY	**FACTOR POSING A POTENTIAL THREAT TO HABITAT**	**ISSUE PRIORITY**
Agricultural Practices	Pesticide use (corn, Christmas trees)	Low
	Nutrients and sediments	High
	Livestock management	High
	Manure/sludge management	High
	Wetlands alteration	Low

	Oil, fuel, and contaminants	Low

Table 1.5. Potential threats to Atlantic salmon habitat quantity and quality related to agricultural activities in the East Machias River watershed.

WATERSHED: EAST MACHIAS RIVER		
AGRICULTURAL ACTIVITY	**FACTOR POSING A POTENTIAL THREAT TO HABITAT**	**ISSUE PRIORITY**
Water Use	Irrigation	Low
Agricultural Practices	Pesticide use	Moderate
	Nutrients and sediments	Low
	Wetlands alteration	Low
	Oil, fuel, and contaminants	Low

Table 1.6. Potential threats to Atlantic salmon habitat quantity and quality related to agricultural activities in the Dennys River watershed.

WATERSHED: DENNYS RIVER		
AGRICULTURAL ACTIVITY	**FACTOR POSING A POTENTIAL THREAT TO HABITAT**	**ISSUE PRIORITY**
Water Use	Irrigation	Low
Agricultural Practices	Pesticide use	Moderate
	Nutrients and sediments	Low
	Wetlands alteration	Low
	Oil, fuel, and contaminants	Low

Table 1.7. Potential threats to Atlantic salmon habitat quantity and quality related to agricultural activities in the Ducktrap River watershed.

WATERSHED: DUCKTRAP RIVER		
AGRICULTURAL ACTIVITY	**FACTOR POSING A POTENTIAL THREAT TO HABITAT**	**ISSUE PRIORITY**

Agricultural Practices	Pesticide use	Low
	Nutrients and sediments	Low
	Wetlands alteration	Low
	Oil, fuel, and contaminants	Low

Agricultural Water Use

Introduction

There is potential for water use conflict between agriculture and Atlantic salmon in some Maine rivers . The primary agricultural activities that have the potential to affect water quantity include: berry processing, irrigating blueberry fields, and production of cranberries. There are other minimal uses, such as livestock watering, in the Sheepscot and Ducktrap Rivers. The existing levels of agricultural water use in the seven rivers are not known to have contributed to the current low populations of Atlantic salmon. However, the effects of additional withdrawal based on industry projections of increased water use will be a factor if the needs of Atlantic salmon are not considered in developing and managing water use.

The wild blueberry industry is the primary user of water for agricultural irrigation in the Downeast river watersheds. Maine's new cranberry industry is a minimal user of water, with only a small acreage in production in the seven watersheds. Irrigation is also used by a few small crop farmers. Of the Downeast watersheds, only the Narraguagus and Pleasant River watersheds support significant agricultural water use. Direct water withdrawal for blueberry irrigation occurs in significant volumes only from the Pleasant River, where there are three pump sites. Currently there are only two large agricultural users of water, and this is not expected to increase in the future.

Approximately 6,000 acres of blueberries are irrigated annually. The blueberry industry currently irrigates an estimated 3,600 acres of crop fields and about 2,400 acres of pruned (next year's crop) fields. In 1995, one of the driest summers on record, less than 1,600 acre-feet of water was used for irrigation. This water was applied to pruned fields during June and on cropping fields during July and part of August. Approximately two-thirds more water was applied per acre to cropping fields than to pruned fields. The amount and timing of water used annually varies with the weather and related moisture conditions. The blueberry industry plans to gradually increase production of the irrigated acreage by as much as 100% by the year 2005. This increase in acreage will include approximately 6,000 acres of crop fields and 6,000 acres of pruned fields. It is estimated that the majority of water needed to irrigate this increase in acreage will come from sources other than the ones used today.

Statewide, the cranberry industry produces on 50 to 60 acres and currently uses approximately 100 to 180 acre-feet (33 to 55 million gallons) of water per year. Approximately three acre-feet of water are needed to supply the needs of an acre of cranberry bed per year, after recycling. The Maine cranberry industry expects to increase acreage in production by about 100 acres (in each of) the next five years (Source: D. Bradshaw). This may include a mix of both (2-3 acre) and (15-20 acre) cranberry operations. Total net water needs for the cranberry industry in the Downeast river watersheds is expected to be about 215 to 315 acre-feet per year. Sources of water are expected to be a combination of direct withdrawal from rivers and streams as well as new impoundments. Groundwater may play a role in some future operations. Water used by cranberry operations is held in ponds and reused as much as possible, to reduce the total amount needed to be withdrawn from natural sources.

There is sufficient annual flow in the river systems to provide water for Atlantic salmon and current and projected agricultural water needs. Therefore, the issue is a water management challenge, not a water shortage problem.

Regulations Pertaining to Water Use

Pump Sites and Withdrawal - (Waters in Unorganized Territories)

The Land Use Regulation Commission (LURC) regulates pumping sites and water withdrawal in the unorganized territories under the provisions of 12 MRSA '685-B,1,C of the Commission's statutes. Areas within 75 feet of minor flowing waters and within 250 feet of major flowing waters are designated (P-SL) Shoreland Protection Subdistrict under the provisions of Section 10.16,I,2 of the Commission's Land Use Districts and Standards. Areas below the normal high water mark of rivers and streams are designated (P-WL) Wetland Protection Subdistricts under the provision of Section 10.16,K,2(a) of the Commission's standards. Alteration of the watertable or water level, water impoundments, and other structures for irrigation projects within a (P-SL) Shoreland Protection Subdistrict or a (P-WL) Wetland Protection Subdistrict require permit approval from the Commission under the provisions of Section 10.16,I,3,b and Section 10.16,K,3,b and c of the Commission's standards.

The Commission has the authority to regulate water withdrawal volumes, timing and rates under the provisions of the Commission's statutory criteria for approval of permit applications, 12 MRSA '685-B,4,C. Under this statutory criterion, the applicant must demonstrate that the proposal will have no undue adverse effect on existing uses and natural resources in the area likely to be affected by the proposal. Furthermore, a proposal for the alteration of the watertable or water level within a (P-WL) Wetland Protection Subdistrict requires a permit by special exception under Section 10.16,K,3,c of the Commission's standards. One of the criteria for a permit by special exception requires that the applicant demonstrate that the proposal can be buffered from other uses and resources within the subdistrict with which it would be incompatible. When reviewing water withdrawal proposals under these statutory and regulatory criteria, the Commission will consider impacts to fisheries resources of the stream or river, and may impose permit conditions on approved proposals to mitigate potential adverse impacts on fisheries resources. Such permit conditions may include restriction on pumping rates, timing and volume of water withdrawn. LURC staff work closely with staff from the Maine Department of Inland Fisheries and Wildlife and the Atlantic Salmon Authority in reviewing irrigation proposals for potential impacts on the fisheries resources of streams and rivers, and to develop appropriate permit conditions to mitigate potential adverse impacts.

Withdrawal - (Waters in Organized Towns)

Two laws give the state Department of Environmental Protection (DEP) authority to ensure that water withdrawals do not significantly affect aquatic habitat. The laws are the Water Classification Program as referenced above, and the Natural Resources Protection Act (38 MRSA '480-A to 480-X).

The Water Classification law charges that "where high quality waters of the state constitute an outstanding national resource, that water quality must be maintained and protected." Class AA waters are designated as outstanding national resources. Also within the anti-degradation policy of the law, existing in-stream water uses (as designated by the DEP in accordance with established criteria) and the level of water quality necessary to protect those existing uses must be maintained and protected. The seven rivers covered by the Conservation Plan are either AA or A. With "fishing" and "as habitat for fish and aquatic life" both specified as in-stream uses for all water quality classes (AA - C), the standards encompass habitat for all life stages, including spawning and egg incubation, as well as invertebrate food. The aquatic life standards for class AA further specifies that the habitat must be free flowing and natural, while class A standards specify natural habitat. Both classes state that aquatic life must be "as naturally occurs", thus preserving the characteristics of natural habitat. If the Department can show that a water withdrawal(s) has caused a waterbody to have water quality below the applicable water quality standard for its classification, the Department can find the withdrawal to be in violation of the Water Classification law.

The Natural Resources Protection Act prohibits certain activities from occurring without a permit from the Maine DEP if the activity is located in, on, or over any protected natural resource or is located adjacent to and operated in such a manner that material or soil may wash into an open water resource. Protected natural resources include rivers, streams, brooks and great ponds. Regulated activities under the Natural Resources Protection Act include draining or dewatering a protected natural resource. The state has authority under this law to ensure that a river, stream, brook, or great pond is not completely drained by a water withdrawal.

Discharge - (All Waters)

The Protection and Improvement of Waters Act (38 MRSA '461-A et al.) states that "no person may directly or indirectly discharge or cause to be discharged any pollutant without first obtaining a license from the Department (DEP)." The law requires that the Board of Environmental Protection issue a license for a discharge only if it finds that a discharge either by itself or in combination with other discharges will not lower the quality of any classified body of water below such classification. All waters of the state are classified in accordance with the State's Water Classification Program (38 MRSA '464) which establishes water quality standards for various classifications. River systems have been classified as AA, A, B, or C. Segments of the seven Atlantic Salmon Rivers are generally classified as AA or A waters. These designations provide the highest level of protection the state has for surface waters. The standards for AA waters include; "The habitat shall be as free flowing and natural. The aquatic life, dissolved oxygen, and bacteria content of Class AA waters shall be as naturally occurs."

The Atlantic Salmon and Flows in the Downeast Rivers

The pattern of natural annual flows (Figure 1, note heavy line) that Atlantic salmon have experienced in natural rivers over the last 30 to 50 years includes low flows in July, August, and September (Figure 1). Peak spring flows occur in late March and early April and autumn rains cause increasing flows during October and November (Figure 1). The variability in this pattern is represented by the randomly selected annual flows (1990, 1984, 1975, and 1962). Late summer flows reflect groundwater discharge, especially in extreme low flow conditions. The overall pattern is similar for the Dennys and Narraguagus Rivers. Weather patterns are different on these two watersheds. Similar patterns occur in the other rivers, however, the volume of annual discharge will be related to watershed size. In addition, the amount of storage in headwater lakes will affect the rate that spring flows decline and the volume of low summer and fall flows (Table 1).

Each life stage of the Atlantic salmon is adapted to these general patterns of flow. Upstream adult movement occurs throughout the summer. It is episodic, relating to increasing flows and changes in temperature (Shepard 1995). Spawning, which occurs in late October and early November (Beland et al. 1982), is triggered by changes in day-length and temperature and is dependent on adequate flow in spawning areas. Eggs will not survive the winter unless water flows through the gravel are sufficient to bring oxygen, to carry away wastes, and to prevent the eggs from freezing. Emergence of fry from the gravel and downstream dispersal occur from mid-May through early June in Maine (Gustafson-Marjanen 1982, MacKenzie and Moring 1988). These fish are not yet strong swimmers and are dispersed by the prevailing flows. Juveniles are present in the stream at all times of the year. Survival of juvenile salmon is positively related to summer and winter discharges (Gibson 1993), with better survival in years with higher flows during these seasons. This is because discharge determines the amount of available habitat with suitable depth and velocity in the river. Smolt migration occurs during peak spring runoff. Smolts travel downriver to the estuary with the spring floods. Emigration coincides with increasing river temperatures (Fried 1977) and increasing river discharge (Jonsson and Ruud-Hansen 1985). During summer, adults hold in pools and deadwaters, these same deep waters hold kelts (post-spawn fish) in winter.

Table 1. Averages for annual mean, minimum, and maximum discharge, (CFS) based on entire USGS record, for each site.

River	Town	Area	Mean	Min	Max
Narraguagus	Cherryfield	227	495	272	761
Dennys	Dennysville	92.4	193	96	292
Sheepscot	N.Whitefield	145	249	115	427

Machias	Whitneville	457	931	-	-
E. Machias	No data	-	-	-	-
Pleasant	Epping	60.6	140	-	-
Ducktrap	No data	-	-	-	-

Figure 1. Annual flow patterns and the times that different Atlantic salmon life stages are in the rivers. (***this figure is currently not available for viewing).***

Approach to Estimating Threat

Irrigation has the potential to cause salmon mortality and reduce habitat. At present, the only potential for Atlantic salmon mortality as a direct result of agricultural water use would be if fish became impinged on pump screens or were drawn into an irrigation system. The likelihood of either occurring has not been assessed. Pumps are not placed directly in juvenile salmon habitat, but in deadwater areas adjacent to juvenile habitat. Irrigation does not occur when smolts are migrating. Although deadwaters are used by adults when irrigation takes place, they would likely avoid the intakes, which are screened to exclude fish (1 cm openings).

By withdrawing water from a river, irrigation has the potential to reduce salmon habitat quality and quantity. Reducing the area of the river (i.e., units 100 m5) that produces Atlantic salmon would represent a direct loss of habitat. By reducing wetted width, water withdrawal reduces available habitat, temporarily. The loss of habitat is not long-term, the habitat is only lost to production while it is dewatered. However, repeated annual reductions in habitat will constrain the carrying capacity of the habitat. Reducing a given unit's ability to produce Atlantic salmon in the long-term or short-term constitutes loss of habitat (Appendix 1). Although the amount and location of habitat for the species are known for several of the rivers, the data needed to predict changes in habitat area and quality that follow water withdrawals are not available. Thus, estimating threat to habitat for each river will be based on characteristics of the river's annual hydrology and general predictions of the affects of each type of agricultural use on water quantity and habitat.

Evaluating the cumulative effects of agricultural water use will be addressed in the Total Water Use Management Plan for each watershed. In addition, a variety of other activities have the potential to affect hydrology. These include changes in land use (rural and recreational development, peat mining), changes in vegetation (forestry), channel restrictions (bridges on major roads), withdrawals (municipal water supplies and aquaculture). All these activities would have cumulative effects of Atlantic salmon habitat mediated through river and groundwater flows.

PLEASANT RIVER WATERSHED

Description of Irrigation

Interviews of irrigators are being conducted by the Natural Resources Conservation Service (NRCS) to evaluate the current and projected water use for this watershed. Based on interim information the Agricultural Working Group believes there are approximately 16 irrigation sites in the Pleasant River watershed, and at least one impoundment planned in the near future. Irrigation water was pumped from eight of the sites in 1995, the driest summer on record. Four sites on the mainstem accounted for the withdrawal of approximately 800 acre-feet of water. Lakes and kettle-hole ponds made up the rest of the approximately 1,300 acre-feet used for irrigation in the watershed in 1995. There was no irrigation from groundwater wells. A distinction has been made between groundwater wells and kettle-holes, which may be outlets to groundwater aquifers. However, experience from using kettle-hole ponds for irrigation in Washington County shows that they normally replenish very slowly. Therefore, they are only limited volume storage ponds.

Evaluation of Threat from Irrigation

It's possible that agricultural water use reduced the amount and quality of Atlantic salmon habitat in the Pleasant River in 1995. The extent of this habitat loss is difficult to assess. Hydrologic gaging data are only available for the period 1981 to 1990, when irrigation in the watershed was ongoing (Figure 2).

Description of Cranberry Culture Water Use

Cranberry culture relies on water for frost protection, irrigation, and wet harvest. Statewide, the cranberry industry produces on 50 to 60 acres and currently uses approximately 100 to 180 acre-feet of water per year. Approximately three acre-feet of water are needed to supply the needs of an acre of cranberry bed per year, after recycling.

There is one licensed cranberry grower in the Pleasant River watershed with five acres in production (1995). This grower uses about 15 acre-feet of water per year. A new operation is proposed for four acres in the town of Columbia Falls, expected water use; 12 acre-feet per year. At least part of this water comes from the Pleasant River or its tributaries.

Evaluation of Threat from Cranberry Culture Water Use

Cranberry operations include water management ponds to hold the appropriate volumes of water, that is withdrawn from the river in spring. Water is recycled in a series of ponds, thereby water extraction from rivers and streams during critical flow periods for Atlantic salmon is reduced. In addition, permits required by DEP require that the level of the intakes for farms be above aquatic baseflow (ABF). The timing and rate of discharge from the ponds may affect stream hydrology. Because acreage in cranberry production is small, the potential to affect the hydrology of Atlantic salmon rivers is also low.

Figure 2. Annual flow patterns for the Pleasant River at Epping, Maine.
(Figure 2 is currently not available for viewing)

NARRAGUAGUS RIVER WATERSHED

Description of Irrigation

Interviews of irrigators are being conducted by NRCS to evaluate the current and projected water use for this watershed. Based on interim information the Agricultural Working Group believes there are approximately 17 active irrigation sites in the Narraguagus River watershed, a number of inactive sites, and at least one planned in the near future. In the Narraguagus River watershed, four sites were on lakes and there was only one site where water was pumped directly from the West Branch of the Narraguagus. Estimated withdrawals from sources in the Narraguagus River watershed were less than 100 acre-feet in 1995, the driest summer on record. Direct withdrawal by pumping water from rivers or streams accounted for about 5 percent of the water used. Great ponds (over 10 acres) and other natural lakes (such as kettle-holes) provided another 20 percent. The balance came from manmade impoundments, on small streams. There was no irrigation from groundwater wells. A distinction has been made between groundwater wells and kettle-holes, which may be outlets to groundwater aquifers. However, experience from using kettle-hole ponds for irrigation in Washington County shows that they normally replenish very slowly. Therefore, they are only limited volume storage ponds.

Evaluation of Threat from Irrigation

The extent that habitat has been affected by irrigation in the Narraguagus watershed is difficult to assess. Direct river withdrawal sites have only been used occasionally in the last several years. However, withdrawal from impounded water will affect low flows if baseflows are not maintained below the impoundment. The size and operation of the impoundments in the Narraguagus River watershed will be part of the data gathering stage of the Total Water Use Management Plan.

Description of Agricultural Process Water Use

The source of water for the berry processing plants in Cherryfield, Maine is an aquifer. The water is used in food processing, washing, and freezing. The volume of agricultural process water discharged to the

Narraguagus River is allowed to reach a total of 627,250 gallons per day, a discharge of 0.97 cfs. Of this discharge, up to 100,000 gallons per day is currently allowed by permit to attain a discharge temperature of 26 C (79 F). The total process water discharge rate is approximately 0.19% of the average annual flow and 0.36% of the average minimum flow.

Evaluation of Threat from Agricultural Process Water

Process Water Volume

Current volumes of process water are probably of little consequence to the hydrology of the Narraguagus River, either in removal from groundwater or discharge to the river. The relatively small volume of groundwater used in processing is extracted near the mouth of the river and will likely have no perceived effect on subsurface hydrology or surface water flows. The process water discharge is near the estuary, with little or no likely consequences to river hydrology. Blueberry and cranberry industry sources expect a potential need to increase processing of blueberries by about 25 percent. Therefore, the projected need for sources of high quality water and related discharge volumes should increase in both the near and long-term future. If current groundwater sources are used and discharges are within permitted volumes, the expected changes in agricultural process water use will likely have minimal affect on the hydrology of Atlantic salmon habitat.

Discharge Temperature

The water temperatures in the Narraguagus River in the vicinity of the process water discharges have not been monitored. Therefore, data are needed before it is possible to predict the effect on Atlantic salmon survival. The known volume of processed water which is used for agricultural purposes is allowed to reach a total of 627,250 gallons per day. This is equivalent to a discharge rate of 0.97 cfs in the Narraguagus River at Cherryfield, Maine. Of this discharge, up to 100,000 gallons per day (0.154 cfs) is currently permitted to attain a discharge temperature of 26 degrees C. The total process water discharge rate is approximately 0.19% of the average annual flows (495 cfs) and 0.36% of the average minimum flow.

Description of Land Applied Agricultural Wastewater

There are two permits for spray irrigation of food processing wastewater in the Narraguagus River watershed. These permits are administered by the DEP. One permit is for 114,000 gal/acre/week and the other for 27,000 gal/acre/week. These maximum application rates exceed maximum expected rainfall events for Downeast Maine.

Evaluation of Threat from Land Applied Agricultural Wastewater

Properly permitted and maintained land applications are not likely to have any adverse effect on stream hydrology or Atlantic salmon habitat. They will add to stream flow.

MACHIAS RIVER WATERSHED

Description of Irrigation

There are nine identified irrigation sites in the Machias River watershed. In 1995, the driest summer on record, less than 200 acre-feet of water were used by the two major blueberry producers. The volume of irrigation water used by smaller growers in this watershed is an unknown. Of the sites identified in initial investigations, many are in the Mopang subdrainage. Mopang Stream has a significant amount of high quality Atlantic salmon habitat (ASA files).

Evaluation of Threat from Irrigation

The Agricultural Working Group has no hydrologic data to estimate the loss of habitat on the Machias River due to irrigation. Gaging on the Machias River by the U.S. Geological Survey (USGS) ended in 1975, and thus would be of little value in trying to assess the effects of current irrigation on Atlantic salmon habitat. The number of units of juvenile habitat identified during low flows seem different for current (1994) and older (1950) surveys. However, once differences in the types of habitat classified as nursery area were reconciled there were only minor differences.

Description of Agricultural Process Water Use

The source of water for the berry processing plant in the town of Machias is an aquifer. The Machias River estuary can currently receive up to 70,000 gallons per day of agricultural process (non-contact) cooling water up to a temperature of 32 C (89 F). This represents 0.01% of the Machias River's average annual flow.

Evaluation of Threat from Agricultural Process Water Use

<u>Discharge Volume</u>

The currently used volume of process water is probably of little consequence to the hydrology of the Machias River, either in its removal from groundwater or its discharge to the river. The relatively small volume of groundwater used in processing is extracted near the mouth of the river and will likely have no perceived effect on surface water flows. The process water discharge is near the estuary, with little or no likely consequences to hydrology. Blueberry and cranberry industry sources expect a potential need to increase processing of blueberries by about 25 percent. Therefore, the projected need for sources of high quality water and related discharge volumes should increase in both the near and long-term future. If current groundwater sources are used and discharges are within permitted volumes, the expected changes in agricultural process water use will likely have minimal affect on the hydrology of Atlantic salmon habitat.

<u>Discharge Temperature</u>

There is the potential for loss of habitat and/or individual Atlantic salmon resulting from the temperature of the process water discharge in the immediate area of the discharge. The maximum discharge temperature to the Machias, 32 C (89 F), is lethal to both juveniles and adults (Danie et al. 1984). The distribution and extent of elevated water temperatures in the vicinity of discharge are unknown. Therefore, data are needed before predicting the effect on Atlantic salmon habitat is possible. The Machias River can currently receive up to 70,000 gallons per day (0.11 cfs) of agricultural process (non-contact) cooling water up to a temperature of 32 degrees C. This represents 0.01% of the average annual flows (931 cfs) and is diluted by discharge into the tidal basin.

EAST MACHIAS, DENNYS, SHEEPSCOT AND DUCKTRAP RIVER WATERSHEDS

The precise extent of agricultural water use in these watersheds is unknown, because there are no significant water users in any of the watersheds. Blueberry culture is present in all but the Ducktrap watershed.

ACTIONS

What follows is a brief description of the processes that will be used to resolve conflicts between agricultural water uses and Atlantic salmon habitat. Approaches to interim conflict resolution and long-term solutions are discussed. The need and detail for specific activities will vary depending on the watershed. The key to the process is having the agriculture water users, Atlantic salmon biologists, hydrologists, agricultural engineers, and environmental regulators work cooperatively and creatively to solve a complex and dynamic problem.

Interim Action:

(WU 1) Agricultural and other human user groups and the Atlantic Salmon Authority, together with other interested parties will work cooperatively, case-by-case, to resolve conflicts that current activities may have with the needs of the Atlantic salmon until long-term assessments and strategies are developed.

State agencies, in cooperation with Federal agencies, agricultural and other human user groups, will work to expand financial and technical assistance which support efforts for using alternative water sources to meet the water needs of agriculture. They will also work to ensure the availability of regulatory or nonregulatory mechanisms to aide in the search for alternative water sources.

Permits issued for construction activities in the watersheds of Atlantic salmon rivers will ensure that appropriate, site-specific flows, for Atlantic salmon will be maintained. The Atlantic Salmon Authority will be invited to attend all preapplication meetings held for projects in the watersheds of the Atlantic salmon rivers.

Complaints received in regard to water use conflicts with Atlantic salmon will be classified as high priority and will be investigated by the DEP and/or the Atlantic Salmon Authority. All parties will work in accordance with this plan to resolve any conflict.

Long-Term Action: Watershed-Specific Total Water Use Management Plans

(WU 2) Develop specific river basin or hydrologic unit based assessments for each of the seven watersheds for both the hydrologic needs of salmon restoration and agriculture. These assessments should include all land and water uses and concerns relative to salmon (i.e., forestry, development, aquaculture, water quality, etc.).

Priorities recommended:

1) Pleasant River 2) Narraguagus River and 3) Machias River. These are where hydrologic concerns and needs are apparently the highest. However, future plans for agricultural expansion (i.e., cranberries) may change this ranking. Planning on other rivers should be done as resources permit.

These assessments will require complete hydrologic and biological assessments by tributary, river reach or segment. Details should be sufficient to use appropriate in-stream, flow-based fishery models for salmon. Agricultural needs and goals will need to be fully assessed.

A primary goal of these assessments is to locate and determine the feasibility of providing additional water storage sites, with the potential to be managed for both improvement of Atlantic salmon habitat and agricultural production.

The Natural Resources Conservation Service (NRCS) has been requested to assist the State of Maine and the partners involved in the Atlantic Salmon Task Force in developing "Total Watershed Management Plans." The plans have the purpose of demonstrating that sufficient water resources exist in Atlantic salmon watersheds to provide water for restoration and protection of habitat as well as agricultural uses. Preliminary inventory of the Pleasant and Narraguagus watersheds (NRCS, 1996) has determined that there will be sufficient water for both uses, however, careful management is critical to Atlantic salmon habitat protection.

This planning effort will be the first in the Eastern United States. It will be similar to water resource planning undertaken in the Pacific Northwest. However, water resource issues in the Northwest are more complex than in Maine. In the Northwest agricultural uses are only one part of the total plan, while in the Downeast watersheds, agricultural water use is the single most significant human use. Like the Northwest, the Maine planning process will rely on interdisciplinary and broad based partnerships to effectively protect salmon habitat and agriculture.

The Total Watershed Management Plans will address site-specific needs of Atlantic salmon and blueberry and cranberry production. Water management in the Downeast watersheds will include impoundments for irrigation, mitigation and/or flow augmentation with the goal of removing pumps from unregulated sections of the rivers. The plan may include remote releases from reservoirs for either irrigation or glow augmentation or both.

Develop a Strategy for Funding Short-Term and Long-Term Planning and Implementation

(WU 3) Funding will be needed for detailed hydrologic and biological studies and monitoring. There will be a need for planning and assessments. These activities far exceed the scope and current budget capabilities of state and federal agencies and the agricultural community. This should be a cooperative effort.

Funding

Funding will be needed for detailed hydrologic and biological studies and will be used to plan, design, construct and maintain anticipated water impoundment structures for flow augmentation, habitat improvements, mitigation and monitoring. These activities exceed the current budget capabilities of state agencies and the agricultural community. Potential sources of funding may include Federal sources (i.e., USDA River Basins, etc.), state grants, tax incentives, conservation organizations, and industry contributions.

Short-term funding is needed to respond to existing needs and the immediate demands on water resources, until the results of long-term plans are available to be implemented. Short-term funding will assist state and federal agencies and the agriculture community with technical evaluations necessary for short-term planning.

The long-term plans and budget estimates include other land and water uses and issues, typical of total watershed based river basin or hydrologic unit inventory and evaluations, conducted by the United States Department of Agriculture (USDA), and Natural Resources Conservation Service.

Estimated Costs

June 1996 through 2009 $1.4 - $2.8 million

(Based on an average of $200,000 - $300,000 per watershed for USDA River Basin Planning)

MONITORING

WU 4 Hydrology

The USGS currently operates gaging stations on the Narraguagus, Dennys, and Sheepscot Rivers. There are two gaging sites in the Pleasant River watershed and one on the Machias River where data are no longer gathered. Data from all the stations are very important in monitoring the effects of agricultural water use on hydrology. The USGS should be requested to reactivate the inactive stations.

Funding

USGS operating funds currently covers operation of these gaging stations on the seven rivers. Additional funds need to be allocated to USGS to record data on the remaining four rivers.

WU 5 Temperature

Define the thermal plume associated with direct discharges of wastewater from the berry processing plants on the Narraguagus and Machias Rivers.

Funding

The cost of this monitoring should be shared by ASA and DEP operating budgets.

ALTERNATIVES

The Total Water Use Management Plan approach to resolving conflicts between agricultural water uses and Atlantic salmon habitat, presented in this section of the Conservation Plan, are the result of considering three major alternatives:

1. Eliminate irrigation from all Atlantic salmon watersheds.

2. Continue irrigation as it currently exists, allowing no expansion of irrigation in Atlantic salmon watersheds.

3. Strengthen regulations pertaining to irrigation practices and increase authority to regulate water use in Atlantic salmon rivers.

Given that: 1) There is no evidence that the existing levels of agricultural water use in the seven rivers have contributed significantly to the current low populations of Atlantic salmon, and 2) there is sufficient annual flow in most of the river systems to provide water for Atlantic salmon and current and projected agricultural needs. Then alternatives one and two seem unwarranted, especially in light of the significant impact that they would have on Maine's economy. <u>Therefore, the issue is a water management challenge, not a water shortage problem.</u> That problem cannot be solved in an expedient or cooperative/creative manner through increased regulation, which would likely involve extensive legal battles. Thus, the Agricultural Working Group adopted the approach of cooperatively developing long-term plans to manage water use that provide adequate water for both agriculture and Atlantic salmon.

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APPENDIX 1: POTENTIAL THREATS TO ATLANTIC SALMON HABITAT

The adverse effects of direct river withdrawal on Atlantic salmon have been of concern in Europe since the early 1900's (Mills 1972). Irrigation was recognized as on of the most significant international threats to populations in the early 1970's (Stanfield 1972). Both authors strongly recommend eliminating direct withdrawals from Atlantic salmon rivers. Agricultural water use conflicts with fisheries in Europe and the western Unites States are different from those in Maine. All life stages of the Atlantic salmon are dependent on suitable river and stream flows for survival. However, there is a distinct difference between survival flow conditions and flows that allow for a higher level of carrying capacity for the species' various life stages.

Effects of Surface Water Withdrawals

Existing blueberry and cranberry culture water withdrawals from the Downeast rivers, associated impoundments, and natural lakes and ponds may affect watershed hydrology in the following ways:

1. Altering patterns of spring and fall runoff.
2. Reducing total annual and seasonal peak flows.
3. Transferring water across watersheds.
4. Reducing summer flows, during June, July and August.

The higher in the watershed that withdrawal occurs, the greater the effects on Atlantic salmon habitat because more of the river is downstream of the abstraction. In addition, multiple withdrawals increase the magnitude of hydrologic change. Impoundments not used for irrigation have the potential for augmenting low flows, which increases Atlantic salmon production (Havey and Davis 1970).

These hydrologic effects have different influences on Atlantic salmon and their habitat. Altering the volume and timing of spring and fall flows can affect the efficiency of flushing and cleansing of fine sediment from juvenile and spawning habitat. The rate and efficiency of upstream migration of adults and downstream migration of smolts could also be affected. Transfer of water among watersheds also transfers fish diseases. Reduced annual flows could affect total available habitat. However, reduced summer flows have the most significant affect on Atlantic salmon populations.

Reduced summer base and peak flows have the following physical and water quality consequences:

1. Reducing habitat area; reducing wetted widths.
2. Changing the quality of remaining habitat by altering available combinations of depth and velocity.
3. Increasing water temperatures.
4. Reducing dissolved oxygen concentrations by reducing aeration.
5. Slowing transport of fine particulate matter, thus increasing biological oxygen demand (B.O.D).
6. Reducing assimilation capacity and dilution of direct discharges.
7. Increasing algal growth on substrate and plant growth in still waters.

These affect Atlantic salmon populations and stream ecology. Juvenile populations are constrained by habitat area and by maximum summer temperatures. They are territorial and each age (0+, 1+, 2+) has specific depth and velocity preferences (Stanley and Trial 1995). This territoriality means that carrying capacity of a river for juveniles are a function of the amount of available habitat.

Survival of juvenile salmon is positively related to summer and winter discharges (Gibson 1993), with better survival in years with higher flows during these seasons. Water temperatures between 14 C and 18 C are optimal for growth, normal feeding ceases at 22.5 C, and death occurs with extended exposure to temperatures exceeding 27.8 C (Stanley and Trial 1995). Minimum daily temperatures are the best means to assess population effects of temperature. ASA data indicates that elevated temperatures could affect habitat suitability in some reaches in Downeast rivers in some years (Beland et al. 1995, Horton et al. 1995). Existing, limiting elevated water temperatures would be exacerbated by increased water withdrawal. Construction of impoundments on tributaries for irrigation could also adversely affect water temperatures, which may or may not be mitigated.

Under unaltered stream flow conditions, there is a given probability of a year having extremely low summer flows and associated changes in water quality (temperature, dissolved oxygen, nutrients, BOD, minerals). The probability of sequential extreme low summer flows decreases with the number of years in the sequence (i.e., $P_{2\,yr.} > P_{3\,yr.} > P_{4\,yr.}$ etc.). Thus, because annual variability in low flows and associated warm temperature and reduced water quality controls year class sizes, the probability of sequential poor year classes of juveniles is also small. Variation in smolt age (2+ or 3+) coupled with variation in age at maturity and repeat spawning typically results in a buffer against the occasional bad year. Extractions can undermine this natural built-in mitigation for low water years. If annual summer flows are constantly low due to irrigation, the population size will be constrained by the available habitat at those flows and will not vary as greatly as when flows were unregulated. The carrying capacity of the river to produce juveniles will be reduced for the long-term, not just for an occasional year. This is loss of habitat. In addition to affecting juvenile populations, reduced summer flows would affect the efficiency and timing of adult upstream movement.

Effects of Water Withdrawal from Impoundments

In addition to altering downstream flows and constraining habitat and thus population size, irrigation impoundments themselves can have significant effects on Atlantic salmon habitat. The most obvious being impounding riverine habitat, permanently flooding riffles and pools used by all life stages during different times.

Water temperatures can increase below impoundments if water is discharged from the surface. Subsurface withdrawals can be used to mitigate this. The impoundment itself offers little more than adult holding habitat. Predator populations can increase in impoundments. Coupled with their potential to slow downstream smolt migration, this means increased losses to predators. Aquatic insect production, primarily of filter feeders, is increased for a short distance downstream of an impoundment because of the discharge of particulates (plankton, fine particulate organic matter) from the impoundment. In special situations, the sediment trapping capacity of an impoundment can benefit salmon habitat; i.e., farm pond on McCoy Brook protects the mainstem Narraguagus from peat silt movement off Denbo Heath peat mine. Similarly, impoundments could trap sediment from poorly designed forestry or agriculture operations, road reconstruction, or gravel mining. However, appropriate erosion control is the best defense for these sources of sediment.

Effects of Water Withdrawal from Natural Lakes and Ponds

These natural waterbodies are part of the watershed and have a role in determining its hydrology. Large amounts of water withdrawal from natural lakes and ponds with surface outflow would eventually have the same effects as withdrawal from the river or an impoundment, because base flows out of the lake are reduced and can adversely affect downstream areas as previously described. In addition, increasing the storage capacity of natural bodies of water by removing water can result in reducing downstream peak flows at a time, during the summer, when flushing flows are especially beneficial.

Agricultural Process Water (food processing, washing, etc.)

Agricultural use of water in the seven rivers for processing is currently limited to the berry processing industries in the Narraguagus and Machias River drainages. The source of the high quality process water is high yield groundwater wells and municipal water supplies. Large volume withdrawals of water from groundwater aquifers have the potential to reduce baseflows, thus affecting the quality of Atlantic salmon rearing habitat. Loss of habitat quality is most likely where wells draw from the same aquifers that contribute substantially to the baseflow.

After the water is used for berry processing, the water may be discharged to the river. Permits for discharges are administered by the Maine Department of Environmental Protection. Existing discharges are permitted to attain temperatures between 26 C (79 F) to 32 C (89 F). High temperature discharge has the potential to block or partially block adult migration in summer, depending on the location of the discharge plume in the river and ambient river temperature. These temperatures could cause mortality, with lethal temperatures at 32 C (89 F) for juveniles and 28 C (82 F) for adults (Danie et al. 1984).

The construction of holding ponds and land application of processing wastewater, is an alternative method of cooling and treating high temperature discharges. There are only two permits to apply wastewater associated with berry processing to land. There may be a need to find land disposal sites for agricultural wastewater as volumes of processing water increases. Permits for each site are administered by the DEP. Any potential effect of this type of application on the hydrology, and thus Atlantic salmon habitat, would depend on the location in the watershed and soil moisture conditions at the time of application, and the volume and duration of the application.

Agricultural Practices

Introduction

Current agricultural practices in Maine are not considered a major threat to Atlantic salmon (p. 50532 Federal Register/Vol. 60, No. 189 Friday, September 29, 1995). While agricultural activities have the potential to degrade or limit Atlantic salmon habitat, the risk is low. This report addresses agricultural practices that potentially threaten Atlantic salmon habitat in the seven rivers.

Low bush blueberry culture is the primary form of agriculture in the five Washington County watersheds (Narraguagus, Pleasant, Machias, East Machias, and Dennys) (Figure 1). Cranberry culture currently comprises less than 10 acres in the Pleasant River drainage, but more operations are planned, in Washington County. In the Sheepscot River watershed, livestock production is the predominant form of agriculture. In all the seven watersheds combined, there are probably less than 400 acres in Christmas trees. The Ducktrap River watershed does not contain significant amounts of agriculture. Many of the potential environmental threats from agricultural operations in all seven watersheds are nonpoint in origin and include pollutants such as sediment, nutrients, pesticides, and petroleum products that may enter the rivers via ground and/or surface water. All farms handle and store petroleum products (oils, fuels) and a variety of other hazardous materials. Road systems, nutrient management, pesticides, and tillage practices differ with each form of agriculture.

In the last five years, the State of Maine, federal agencies, University of Maine, and the agricultural community have developed Best Management Practices (BMPs) and have encouraged farmers to voluntarily adopt them to address potential Nonpoint Source (NPS) pollutants. BMPs focus on preventing and/or minimizing contamination of ground and surface water and assuring that documented ground and surface water degradation is appropriately addressed. The agricultural community is also adopting Integrated Crop Management (ICM), which includes Integrated Pest Management (IPM). One of the objectives of ICM is to reduce water pollution.

This portion of the Agricultural Working Group report will focus on watershed-specific plans to minimize the contamination or alteration of Atlantic salmon habitat from agricultural sources. Three areas of concern will be addressed; NPS pollution, wetlands alteration, and direct discharges from food processing plants. Within the NPS pollution category nutrients and sediments, pesticides, and petroleum products will be discussed separately.

Figure 1. Distribution of blueberry production in Maine.
(Figure 1 is currently unavailable for viewing.)

Existing Programs and Regulations

Integrated Management Initiatives

There are two approaches to crop production that have been adopted by the agricultural community to make their operations more economical and environmentally friendly, ICM and IPM. ICM is a system for reducing chemicals, fertilizers, and irrigation water volumes needed for optimum crop production. ICM requires growers or trained scouts to monitor their fields for insects, weeds, and diseases. ICM has two objectives: to enhance profits for farmers and to reduce water pollution. It includes prescriptions for fertilizer use, crop rotation, irrigation, and organic waste management that increase the economic return from a crop. IPM, an integral part of ICM, is a multifaceted and systematic approach to pest control. IPM calls for using just enough chemical to control insects and weeds, rather than trying to eradicate these pests. IPM establishes economic and aesthetic thresholds and monitors for pests and natural controls. Pest management decisions are based on pest levels, their potential for damage, and the status of natural controls. Control is undertaken only when potential damage is sufficient to warrant action. Management of pests includes cultural practices, mechanical and biological controls, as well as chemical control. The goal of IPM is to achieve pest control that is economical and environmentally sound.

The University of Maine Cooperative Extension (UMCE) has been working closely with blueberry growers to develop IPM programs. Included is an educational program that centers around three field days, each year, to demonstrate the least toxic pest management alternatives and most environmentally sensitive cultural techniques. They also provide blueberry growers with the "Wild Blueberry Growers Guide" free of charge. The guide is updated annually with fact sheets that identify insect pests, threshold levels, pesticide application rates and BMPs.

UMCE has also developed an educational program for new cranberry growers that includes recommendations for cranberry pest management. Most Downeast growers use IPM to reduce the use of agricultural chemicals and an annually updated "Cranberry Agriculture in Maine: A Grower's Guide," is distributed to all cranberry growers.

<u>Nonpoint Source Pollution Control Programs</u>

In Maine, several programs have been developed to address nonpoint source pollution of ground and surface water from agriculture. The programs that are relevant to the farming community, in the seven rivers listed in the federal register, are described in the following documents:

1. Strategy for Managing Nonpoint Source Pollution from Agricultural Sources and Best Management System Guidelines, NPS Agricultural Task Force, 1991 (NPS Nonpoint Source Program).

2. Maine Coastal Nonpoint Source Control Program, State Planning Office (Coastal Zone Management (CZM) Nonpoint Source Program), Draft, 1995.

3. State of Maine, Generic State Management Plan for Pesticides and Ground Water (GSMP), Gould, T.L. 1994.

Each of these programs was developed by groups that included federal and state agency staff, industry, farmers, and the general public.

The NPS and GSMP nonpoint source programs have been approved by the Environmental Protection Agency (EPA). Maine's GSMP for groundwater protection was one of the first approved by EPA and is considered a model for other states. The CZM Program is presently being reviewed by the EPA. These programs deal directly with agricultural activities in the watersheds of the seven rivers named in the federal register. The goals of these programs include:

1. To prevent and/or minimize potential contamination of ground and/or surface water, both on and off farms, and

2. To assure that existing, documented degradation of ground and surface water from agricultural practices, both on and off farm, is appropriately addressed.

These programs recognize the pollutants that have the potential to contaminate ground and surface water. The NPS program specifically identified sediment, nutrients, pesticides and manure as being the potential agricultural pollutants. The CZM program also identified grazing management, wastewater from confined animal facilities, and irrigation.

Implementing BMPs is the key to the voluntary NPS programs currently in place. An agricultural BMP is defined as "a method or practice which, when installed or used is consistent with efficient practical, technically and environmentally-sound animal or crop production practices. For those practices that have an impact on water quality, BMPs are those practices best suited for preventing, reducing or correcting surface and groundwater contamination" (NPS Agricultural Task Force 1991). Farmers are encouraged to adopt farming practices (BMPs) that will prevent, reduce or correct contamination of surface and groundwater. Technical assistance from the Soil and Water Conservation Districts (SWCDs), UMCE and Natural Resources Conservation Service (NRCS) help farmers select site-specific BMPs.

The NPS program contains a mandatory compliance component that includes; two tiers of enforcement complaint response and formal enforcement. The first tier is a complaint response system operated by the Maine Department of Agriculture, Food and Rural Resources (DAFRR). Under this system, all agriculture complaints are received and investigated by DAFRR. In consultation with other experts, DAFRR recommends site-specific BMPs to remedy and/or prevent any water quality problems. Farmers are granted protection from nuisance liability when they use BMPs (17 MRSA '2805).

If a farmer does not adopt recommended BMPs, the case is referred to Maine Department of Environmental Protection (DEP) or the Attorney General's Office for the second tier of enforcement. DEP enforces BMPs under the Waste Discharge Law (38 MRSA '413), which prohibits the discharge of any pollutant into waters of the state. There is an exception for agricultural discharge if a farmer has an erosion and sedimentation control plan approved by the DEP. In addition to DEP enforcement, the Attorney General's Office can require BMPs as a civil remedy in a nuisance lawsuit.

Biosolids

Municipal wastewater treatment residuals are occasionally used in agriculture as fertilizers and soil amendments. Their use is regulated by DEP under 06-096 CMR Chapter 567 *Rules for Land Application of Sludge and Residuals.* Land spreading of residuals, such as sewage sludge, has the potential to contaminate surface or groundwater if not handled properly. Therefore, spreading sites must be permitted. The DEP educates sludge generators about how to properly store and spread residuals and provides ongoing training on use of BMPs.

Pesticides

Pesticide use in Maine is regulated by the Board of Pesticides Control (BPC). The BPC operates under two statutes, 7 MRSA '601-625, Chapter 103, and 22 MRSA '1471, Chapter 258-A. The purpose of the Board is to assure that the public benefits from the safe, scientific and proper use of pesticides. In addition, the Board is currently implementing federal initiatives for protecting groundwater and is also exploring a system for disposing of obsolete pesticides. The Board has four primary programs:

1. **Pesticides Registration** - All pesticide manufacturers and distributors, doing business in the state, must register their products on an annual basis, and submit copies of the labels and material safety data sheets. The BPC also conducts human health risk assessments of active ingredients, when concerns are raised that a specific chemical may cause adverse health risks that were not identified in the federal registration process. For example, the BPC's Toxicologist and Medical Advisory Committee reviewed health studies on hexazinone (Velpar) which was the subject of a citizen's petition to ban its use for controlling weeds in blueberry fields.

2. **Certification and Licensing** - The BPC is intensively involved in the training and licensing of a wide range of pesticide dealers and applicators to ensure that products are stored, handled and applied properly. Activities include developing study manuals, exams and training programs, administering written and oral exams, issuing licenses, maintaining computer databases of all licenses, and monitoring training sessions to recertify all applicators and restricted use pesticide dealers.

3. **Enforcement -** The BPC's one full-time and four seasonal inspectors spend most of their time conducting routine inspections to check registration status of pesticide products and to make sure applicators and dealers are aware of and complying with state and federal regulations and pesticide label requirements. When a citizen complaint is received, they conduct a full priority investigation of the application and any resulting adverse effects. If any violations are detected, case summaries are prepared and presented to the BPC for a decision on appropriate enforcement action.

4. **Education** - The BPC emphasizes the importance of educating applicators and dealers on correct procedures to prevent improper use rather than seeking penalties after violations occur. In addition, the BPC is also committed to educating the general public and health care professionals on the risks inherent in pesticide use, procedures to properly apply pesticides around homes and gardens, and reasons why

pesticides are used in agriculture, forestry and other industrial applications.

Information is distributed in a quarterly newsletter, brochures, pamphlets, press releases, and at meetings organized by the BPC, Cooperative Extension, commodity groups, trade organizations, and civic clubs. Finally, staff respond to numerous requests from concerned citizens and students seeking technical information about pesticide use in Maine.

In addition to these four primary programs, the Board of Pesticides Control has been working with EPA since 1987 to develop a strategy for protecting groundwater from pesticide contamination. In June 1994, the BPC completed work on a *Generic State Management Plan for Pesticides and Ground Water* that lists government agencies involved with groundwater resource protection, describes their roles within the planning process, and describes how overlapping authorities will be coordinated. The document also characterizes Maine's groundwater resources, describes pesticide usage patterns, and details contamination prevention measures such as BMPs, user education, and technical assistance. If these measures are unsuccessful, it also establishes action levels where regulatory measures may be needed. To help determine what controls are needed and to allow for public participation, the BPC has created a framework for a unique Pesticide State Management Plan Advisory Committee for each pesticide of concern.

The BPC is currently developing a specific plan for hexazinone, *Hexazinone State Management Plan for the Protection of Ground Water*, which is due to be adopted through rulemaking in 1996. BMPs specific to hexazinone applications were developed as part of the plan (Appendix 1). The BPC will adopt specific actions that may include licensing of purchases and users and a prohibition on airblast sprayers.

The following rules administered by the BPC protect Atlantic salmon:

Pesticide Container Disposal and Storage - This rule was developed to prevent improper disposal of containers in or near waterbodies. It is the nation's only mandatory deposit and return system for restricted use pesticides sold in glass, metal or plastic containers. Growers must pay a deposit at the time of purchase, dealers must affix alpha-numeric stickers and the deposit is not refunded until the containers have been inspected for triple rinsing by BPC staff.

Standards for Outdoor Applications - This rule establishes general standards of conduct for applicators and requires them to minimize drift to the maximum extent practicable under currently available technology. Applicators working in the vicinity of sensitive areas must take extra precaution to protect them from pesticide drift. Included in the definition of sensitive areas are waterbodies such as streams, brooks, rivers, ponds, lakes, estuaries, marine water and wetlands.

Designation of Critical Pesticide Control Areas - The BPC has authority to designate areas where pesticide use may be restricted in order to protect the health, welfare and the environment. Criteria for such a designation include protecting an endangered or threatened species and its habitat, and the quality of surface or groundwater. There are currently two areas so designated and aerial application is banned nearby. They are the Deblois Fish Hatchery and an area along the Dennys River.

<u>Petroleum Products</u>

Growers must handle and transport oil, fuel and coolants in a manner consistent with federal and state laws. Proper procedures for the collection and disposal of these materials include contracting with firms specializing in safe disposal and being prepared to contain any accidental spills. Fueling spills must be cleaned up immediately and reported to the Maine DEP (Appendix 2).

DEP oversees design, installation, replacement, operation, and closure of underground tanks and facilities and responds to accidental spills of oil and hazardous materials. Leaking storage tanks and petroleum spills contaminate soils and have the potential to leach into ground or surface waters. Oil spill response activities undertaken by DEP are intended to either stop or minimize the impacts of spills on ground or surface waters. The DEP maintains a toll free number for reporting oil spills (800-482-0777) and has response staff on-call 24-hours a day. Response services are designed to address any emergency contaminant spills that may occur. The following statutes relate to hazardous materials:

1. Title 38 MRSA '543 prohibits the discharge of oil into waters of the State.

2. Title 38 MRSA '548 requires that any person discharging oil remove the discharge, to the DEP Commissioner's satisfaction.

3. Title 38 MRSA '550 requires the responsible party to report discharge, within two hours, to promptly remove the discharge, and to reimburse the DEP for any expenses.

4. Title 38 MRSA '491, 561 et seq., and 38 MRSA '865 require registration of all underground oil storage facilities and give DEP authority to develop rules for design, installation, replacement, operation, and closure of underground tanks and facilities.

<u>Wetland</u>

Approximately a third of Maine is covered by wetland. Each Atlantic salmon watershed contains a significant amount of wetland that contributes to the value of Atlantic salmon habitat. The State of Maine and the Federal Government regulate activities that impact wetlands (Appendix 3). Under Maine=s Natural Resources Protection Act (NRPA) many normal farming practices are exempt from Wetland Alteration permit requirements. However, impact to surface waters such as streams would require a permit under NRPA. Cranberry farming activities that propose to disturb wetlands are not exempt and must receive wetland alteration permits prior to construction. Maine has adopted a General Permit that provides for an expedited process when the project is developed on low or moderate value wetland. The General Permit imposes design and siting criteria, erosion control standards, and storm water containment standards that minimize impact to adjacent soil and water resources. The Federal cranberry permit system is somewhat similar, but imposes stricter standards on the proposed activity as the area of impact increases. The USFWS, NMFS, and EPA are given the opportunity to comment on proposed impacts. Cranberry and irrigation projects that affect higher value wetlands or do not meet General Permit standards are reviewed under individual permit criteria.

<u>Direct Wastewater Discharge</u>

Maine DEP issues and regulates waste discharge licenses under Title 38 MRSA '413, Chapter 3. The current DEP Waste Discharge License laws provide for: waste load limits, monthly monitoring reports, planning for emergency events such as spills, and compliance checking.

Potential Threats to Atlantic Salmon and Their Habitat

<u>Nonpoint Source Pollution</u>

For the purposes of this report NPS pollution will be divided into three subcategories; nutrients and sediment, pesticides, and petroleum products. Nutrient enrichment or eutrophication results when manure, biosolids or chemical fertilizer enter a river, either in surface runoff or groundwater. Sediment from agricultural road building and tillage of cropland is another potential threat to Atlantic salmon habitat. Bare soils may erode during snowmelt and storm events, carrying sediment to adjacent rivers or streams. Atlantic salmon habitat can also be impacted by degraded riparian areas and streambank erosion because riparian areas influence hydrology, are infiltration zones for runoff, and provide shade that moderates river temperature. Pesticides may enter waterbodies directly as a result of mis-application or accidental spills, or in contaminated surface runoff and groundwater. Petroleum products pollute surface runoff and groundwater, following accidental spills or from leaking storage tanks. NPS pollution directly influences water quality and riverine sediment load, both of which affect Atlantic salmon survival.

Nutrients and Sediments - Excessive nutrient enrichment of a river will increase growth of aquatic vegetation and reduce the carrying capacity for Atlantic salmon. Potential effects include:

1. Increased respiration and decomposition of plants may cause dissolved oxygen to fall below levels optimal for Atlantic salmon survival.

2. Excess algae in the water column can decrease visibility for sight feeding salmon.

3. Excess aquatic vegetation (algae growing attached to rocks and macrophytes) in juvenile salmon habitat decreases salmon populations.

4. Nutrient enrichment directly influences macroinvertebrate communities. Habitat quality for salmon is a function of the composition and density of aquatic invertebrate communities.

Introduced sediment changes the physical structure of a river=s substrate, a critical factor in salmon survival. From the egg through the juvenile stages, salmon need clean gravel and cobble substrate through which water can easily flow (Stanley and Trial 1995). NPS sediment can settle into the spaces between the gravel and cobble and embed the substrate. Embedded substrate in spawning areas will reduce egg survival, and in juvenile rearing areas will reduce carrying capacity.

Pesticides - Pesticides include insecticides, fungicides, and herbicides. Of these, insecticides usually have the highest acute toxicity for Atlantic salmon, followed by fungicides, and herbicides (Table 1). The effects of pesticides on Atlantic salmon depend on the concentration and chemistry of the pesticide, water quality (i.e., pH, temperature, conductivity, alkalinity), and flow. The effect of any given pesticide on salmon can vary from death through mild impairment to no effect, depending on concentration and duration of exposure. The acute effects of a pesticide on fish are usually reported as the LC50 (lethal concentration to 50 percent of the individuals in a given time). Salmonid LC50's exist for most of the pesticides used in Maine agriculture, but the effects of chronic sublethal exposure are virtually unknown. Sublethal concentrations of pesticides may impair behavior or physiological functions (Trial 1986). Chronic exposure to low levels of pesticides may stress the fish. Endocrine systems may be disrupted by pesticides, affecting sexual maturation (Dr. S.B. Jones, National Biologic Service, Personal communication).

Table 1. Registered pest control products used on Maine lowbush blueberries, water solubility, half-life and fish toxicity ***(Table 1 currently not available for viewing.)***

Pesticides in a river can also affect salmon habitat quality through food web interactions. Insecticide levels that do not affect salmon may cause invertebrate drift or mortality (Trial 1986). If long-term reductions in food availability result, then salmon growth and survival would decrease.

For a pesticide to affect Atlantic salmon populations it must enter aquatic habitat. Proper application reduces the likelihood that pesticides will reach the aquatic environment and affect local salmon populations. Spray technology has been refined over the last few decades, reducing the amount of pesticide needed, and thus reducing the risks to the aquatic environment. Pesticides are applied to take advantage of appropriate wind conditions that minimize airborne drift. IPM promotes pesticide application only when a field reaches threshold pest populations. Reduced amounts of applied pesticides lowers the risk to Atlantic salmon.

Petroleum Products - All agricultural operations use petroleum products in the course of their activities. An accidental spill in or adjacent to any of the seven rivers could result in mortality of Atlantic salmon. In addition, petroleum products could enter a river in contaminated groundwater caused by spills or by leaking from underground storage tanks. Acute and sublethal effects of petroleum spills to salmonids are well documented in both estuarine and freshwater [i.e., Exxon Valdez, South Dakota 1969, (EPA 1986)] habitats. The risk of a significant spill occurring to a river is low, based on DEP records. Safeguards are in place to minimize the risk that spills, large or small, will contaminate surface or groundwater, thus protecting Atlantic salmon habitat. In 1986, Maine mandated the removal or updating of underground storage tanks, almost eliminating the potential for these tanks to contaminate groundwater.

Wetland Alteration

Converting wetlands to agricultural production may lead to increases in river sedimentation or changes in hydrology that indirectly affect Atlantic salmon habitat. Wetlands protect water quality and quantity by trapping sediment and nutrients, stabilizing streambanks, and storing flood waters. Most agricultural wetland alterations affect low value wetlands, minimizing impacts to important functions. Pasturing livestock in riparian wetlands decreases streambank stability and increases runoff rates. The threats associated with developing irrigation impoundments are discussed in Water Use Appendix 1. The major type of conversion in the seven watersheds is probably that for cranberry production. Because wetland alterations do not directly threaten Atlantic salmon habitat, the watershed-specific discussions will combine wetland alterations and NPS pollution.

<u>Wastewater Discharges</u>

Effluent from agricultural point source discharges have, in the past, degraded downstream water quality. Direct discharge of blueberry plant process water increases the river=s biological oxygen demand (BOD), decreasing dissolved oxygen, and increases total suspended solids (TSS). Low levels of dissolved oxygen can block or delay adult migration upriver (Danie et al. 1984). Increased organic load (BOD) and TSS can reduce carrying capacity for aquatic invertebrates and juvenile salmon. There are two berry processing plants on the Narraguagus River and one on the Machias River.

Approach to Evaluating Threats to Atlantic Salmon and Their Habitat

Within each watershed, agricultural practices are identified that pose the greatest threat to Atlantic salmon and their habitat. No attempt will be made to quantify these threats, because the ephemeral nature of NPS pollution, combined with a mobile species like Atlantic salmon, would make estimates speculative at best. In addition, low numbers of adult salmon make it difficult to use current population trends as an indicator of NPS problems. Sediment and nutrient loading in the seven rivers has not been quantified, nor have any corresponding affect on substrate embeddedness. Although pesticides have been detected in some of the systems, they are below lethal levels. With little known about sublethal effects of pesticides on Atlantic salmon, quantifying these effects is impossible. The risks of accidental spills of both pesticides and petroleum products are judged to be low, and there are emergency procedures that minimize these risks.

SHEEPSCOT RIVER WATERSHED

Activities that have the Potential to Generate NPS Pollution

The Sheepscot watershed contains the most diverse agriculture of the seven watersheds included in this report. Dairy farming is the primary agricultural enterprise, with forage corn and hay grown to feed livestock. Herbicides are commonly used in the production of corn. Nutrient management is required to grow both crops, involving the proper use of fertilizers and manure. Biosolids are also used as soil amendments in the Sheepscot watershed. The risk of agricultural nonpoint source (NPS) pollution is highest in the Sheepscot River because livestock farming developed adjacent to the river. In addition to dairy and beef animals, there are sheep, horses, pigs, and llamas that graze near the Sheepscot River and its tributaries. Without proper livestock management and exclusion to maintain stable banks and vegetated riparian areas, wetlands in the riparian zone may be altered.

Several hundred acres of forage corn are grown along the Sheepscot River, primarily in the upper watershed, above salmon spawning and nursery areas. The herbicide atrazine is the major pesticide used on this crop.

There are approximately 100 acres in Christmas tree plantations in the Sheepscot River watershed. These fields are not tilled but have annual applications of herbicides (Appendix 4) applied to maintain a strip of unvegetated soil under each row of trees. This maximizes growth of planted Christmas trees. Trees may also be fertilized. In addition, occasional insect outbreaks are controlled with a variety of insecticides (Appendix 4). Dairy and Christmas tree farmers must handle and transport oil, fuel, and coolants because these operations use agricultural machinery.

Evaluation of Threats from NPS Pollution

The major threats to Atlantic salmon habitat in the Sheepscot watershed are sediment and nutrient loading. Previously altered wetlands on fine textured soils contribute to the nutrient loading in the system. Recent surveys by Sheepscot Valley Conservation Association have detected substantial bacterial contamination in the river (Unpublished reports). Although this does not directly address water quality issues related to Atlantic salmon, it does demonstrate the presence of NPS pollutants.

Temperature monitoring, since 1994, has identified sections of the river that are too warm for salmon growth and survival (Horton et al. 1994). This phenomenon is not directly attributable to current agricultural production along the river. However, historic conversion of forest land to agriculture may have contributed to changes in hydrologic and thermal regime. Future wetland alterations should pose less threat because they are limited by federal agricultural regulations tied directly to technical and financial assistance programs.

Biosolids land application standards include; soil type, setbacks from waterbodies, slope restrictions and management standards to minimize ground and surface waters contamination. Ground and surface water monitoring is generally not required because of the stringent siting and management requirements. Variances from siting standards do require groundwater monitoring.

The pesticide atrazine is water soluble and has been detected in other states in surface waters adjacent to areas of application. In September 1996, the Board conducted a small-scale, retrospective study of 44 sites which had detectable levels of one or more corn herbicides during a 1992 Triazine in Ground Water Study. The project included samples from two sites in Windsor and one in North Newcastle, in the Sheepscot watershed. One well in Windsor had a residue reading at less than established drinking water guidelines and the other two samples did not have detectable levels of any of the herbicides. Similar results were obtained for the other 26 sites adjacent to corn fields in other regions where only 34.5% had detectable residues and none exceeded guidelines. The Board is hopeful this is a sing the 1993 label amendments and increased educational activities have been successful in reducing both ground and surface water contamination from these highly soluble herbicides. The results will be used in preparing a state management plan as soon as EPA completes their federal rulemaking process.

There are no known ongoing discharges of petroleum products in the Sheepscot watershed. In the past, small amounts of oil-contaminated soil were land spread, away from surface water, under DEP supervision. There are no point source discharges from agricultural processing plants into the Sheepscot River.

NARRAGUAGUS, PLEASANT, MACHIAS, EAST MACHIAS, AND DENNYS RIVER WATERSHEDS

Activities that have the Potential to Generate NPS Pollution

These watersheds have acreage in blueberry and cranberry production. The Narraguagus and Pleasant Rivers have the largest acreage in blueberries followed by the Machias, East Machias and the Dennys Rivers. Cranberry production is limited to the Pleasant River watershed. Both types of operations handle and transport oil, fuel, and coolants because these operations use agriculture machinery.

Blueberry Culture

Wild blueberries are produced on 60,000 acres of native stands, located principally along the coastal glacial outwash plains (Figure 1). Most of the towns in the five Atlantic salmon watersheds within Washington County have blueberry fields. The plants are pruned by burning or mowing every other year, with a crop produced on a given field every other year. A variety of petroleum products are used for burning. Because of the pruning cycle, different pesticides may be used depending on whether a field is bearing or nonbearing. Erosion control programs are in place for agricultural road systems maintained by large blueberry growers. Fertilizer recommendations, based on blueberry leaf analysis, ensure that only the proper amount of fertilizer is applied, thereby avoiding excess fertilization. Training on leaf sampling and interpretation of results is part of ICM. The fertilizers most commonly used are diammonium phosphate and monoammonium phosphate. Blueberry production evolved on suitable lands near but not necessarily adjacent to rivers. Many fields are on sandy soils that tend to infiltrate stormwater. Because the soil is not tilled erosion potential is low. Vegetated buffers, generally in excess of 150 feet, minimize runoff and NPS pollution.

A pesticide use survey compiled from growers' records in 1992 indicated that 49 percent of the pesticides used were herbicides, 29 percent were insecticides and 22 percent were fungicides. The total reported pesticide use, per acre, in wild blueberry fields was 0.239 pounds of dry product and 0.296 gallons of liquid product. Some acreage may not receive a pesticide application in a given year because of ICM practices.

Hexazinone (Velpar, Pronone), the most widely used herbicide, is applied during the spring of nonbearing years. Hexazinone has a high water solubility (33,000 mg/kg), and long half life (90 days). It has an affinity for organic matter but does not adsorb tightly to the mineral portion of the soil. As a result, most of the hexazinone remains in the upper layers of the soil. However, heavy rains will leach a small portion of hexazinone into the lower soil layers which may eventually result in groundwater contamination. IPM has, in part, been responsible for reducing the amount of hexazinone used from 1.78 lbs/acre in 1991 to 1.23 lbs/acre in 1995. Low but detectable levels (<10 ppb) are consistently found in the ground and surface waters adjacent to blueberry fields (Yarborough et al. 1993). BMPs have been developed specifically to reduce the potential of hexazinone intrusion to groundwater (Appendix 1).

Minimal amounts of the herbicides glyphosate (Roundup), fluazifop-butyl (Fusilade), sethoxidim (Poast), terbacil (Sinbar), and 2,4-D are used. These are primarily applied selectively as a spot treatment to weeds in the fall. Glyphosate is tightly bound to soil, therefore, although it has a high solubility, it is not mobile. No residues of glyphosate have been found in groundwater in Maine blueberry fields.

The insecticide azinphos-methyl (Guthion, Sniper) was used by 18 percent of the growers surveyed. It is aerially applied to control the blueberry fruit fly in July. Traps are used to monitor fly populations and applications are made if threshold levels are met. Other insecticides, used by less than 3 percent of the growers, are phosmet (Imidan) and methoxychlor (Marlate). Most insecticides are applied by aircraft or ground airblast sprayers, and may be applied in one or both years of the crop cycle, depending on the insect pest.

Fungicides are sprayed on fields in late May and June to prevent disease problems. The most common fungicide was triforine (Funginex), used by 7 percent of the growers surveyed, Benomyl was used by 2.3 percent of the growers. Combinations of these two fungicides were used. The spring of 1996 may be the last season of use for triforine, because the manufacturer may not pursue re-registration. Triforine will eventually be replaced by a new registered product called Orbit that has already been registered for use on ornamentals. It is currently being evaluated for use on food crops.

Cranberry Culture

The cranberry industry is relatively new to Maine. The first cranberry beds were established in 1989 in Jonesboro. As of May 1996 there were approximately 28 growers managing 66 acres in Maine. Nearly all use pesticides and fertilizers in the course of their operations. Approximately 20 pesticides (Appendix 4) are available for use by cranberry growers. It is likely that only a few of these materials would be used by an individual grower during a given season. Pesticides may be delivered to the beds via chemigation (chemicals applied during irrigation). Beds may be constructed in low value wetlands, but more often are built in a mix of wetland and upland sites. Cranberry beds are designed with water recovery systems to minimize off-site movement of pesticides. Growers block off the bed outlets prior to applying any chemical. In addition, the outlets of the holding ponds are also shut protecting downstream areas from contamination. Cranberry beds that have received Maine or Federal permits must be able to retain a 25-year storm event within the beds or reservoirs. If bedwater escapes during a storm, in excess of design, high flows in receiving waters would dilute any runoff from the operation.

Evaluation of Threats from NPS Pollution

Few threats to Atlantic salmon from agriculture were identified in these watersheds. Little or no threat exists in these watershed from sediment and nutrients. There is no observable evidence of nutrient enrichment in these watersheds. Adequate buffers (>150 feet) exist between blueberry fields and salmon rivers in Washington County. Buffers serve to absorb stormwater runoff which carries fertilizers from target sites, protecting Atlantic salmon habitat. Fields are fertilized in prescribed amounts, and little reaches the rivers, resulting in minimal nutrient enrichment. The amount of fertilizer used on blueberries is minimal in comparison to most agricultural crops. Runoff from the flat blueberry fields that have sandy soils (high infiltration capacity) is minimal during the growing season. Therefore, there is little likelihood that substantial amounts of fertilizer will runoff. There is the potential for nutrients to reach the rivers in groundwater. Erosion is associated with roads and culverts within blueberry operations. Sites with noticeable erosion need to be stabilized and maintained. DEP, LURC, ASA and IF&W would have the responsibility and ability to detect and report problems of nutrient enrichment as well as sedimentation from poorly designed agricultural roads and stream crossings.

In parts of the Narraguagus and Pleasant Rivers, Atlantic salmon are exposed to low background levels of hexazinone. The hexazinone concentrations are 1,000 times lower than reported LC50 of 240-320 ppm for salmonid fishes. Various effects have been observed in fish exposed to sublethal levels of toxic chemicals, but no information currently exists on the chronic sublethal effects of hexazinone on salmonids. Further studies are required to determine if constant hexazinone exposure has any sublethal or chronic effects on salmon development.

Based on existing monitoring, Atlantic salmon and aquatic invertebrates apparently are not exposed to insecticides in the river. Bushway et al. (1982) found no azinphos-methyl in surface waters adjacent to blueberry fields in 1980 and 1981, but did detect it in groundwater below a sprayed field and in the washwater from a blueberry plant. In 1991 and 1993, stormwater monitoring did not detect any azinphos-methyl in surface water immediately after application (Beland et al. 1994). Several factors work together to keep insecticides out of the rivers: their water solubility is low and they break down quickly; insecticides are applied during July, usually a dry month, and probably breakdown before runoff washes them into the river; and large buffers along the river serve to prevent insecticide runoff from entering the river. Aquatic invertebrate community density and diversity have not changed significantly in the Narraguagus River, comparing 1991-1992 to 1974 samples (Siebenmann 1995). This suggests that water quality conditions capable of supporting healthy Atlantic salmon prey populations in 1974 still exist in the 1990's.

The fungicide benomyl (Benlate) and its main metabolite, carbendazim, are highly toxic to fish but were not detected on the Narraguagus (Beland et al. 1994). These results are consistent with the breakdown and low solubility characteristics of these chemicals. The fungicide triforine (Funginex) was found in the Pleasant River and in groundwater close to where it was sprayed. Triforine is reported as nontoxic to fish (Marsh 1977).

Cranberry operators in Maine have not converted the highest value wetlands to production. Instead, they develop upland and low value wetland sites. With less than ten acres of commercial cranberries in the Pleasant River watershed, and a functioning tailwater recovery system, the possibility of pesticides reaching the river is minimal.

Description of Direct Wastewater Discharges

There are two blueberry processing plants with permitted discharges to the Narraguagus River. The discharge points, some of which empty into a drainage ditch before flowing into the Narraguagus River, are within less than a quarter of a mile of each other. In all, there are three different types of discharges:

1. Cooling water from the canning line: 252,000 gals/day that must first pass through a shaker screen is limited to 281 lbs. of BOD and 479 lbs. of TSS daily.

2. Condenser cooling water: 370,000 gals/day with a maximum temperature of 26 C (79 F).

3. Treated sanitary wastewater: 5,250 gals/day.

There is one processing plant on the Machias River with a license to discharge. The license allows a discharge of 70,000 gal/day of non-contact chlorinated cooling water to the Machias River with a maximum temperature of 32 C (89 F).

Evaluation of Threats from Direct Wastewater Discharges

Effluent from agricultural point source discharges is monitored monthly, and there have been no recent enforcement actions at either of the three plants. Land applications of process water are being used to reduce the amounts of BOD and TSS discharged to the Narraguagus River. Threats from high temperature are discussed in the section of the report dealing with Water Use. The companies responsible for these discharges continue to work with DEP to minimize the impacts of their processing effluent on the rivers. In the past, these discharges degraded downstream water quality, but at no time were adult Atlantic salmon prevented from successfully ascending rivers.

DUCKTRAP RIVER WATERSHED

The Ducktrap River watershed does not contain a significant number of agricultural enterprises.

ACTIONS

Maintain Existing Programs

AP 1 As a result of the proposed listing and the process of developing this report, the Agricultural Working Group identified a number of existing programs that, in many of the watersheds, are effectively protecting Atlantic salmon and their habitat. These programs need to be promoted, bringing them to the attention of all agricultural communities, in the seven watersheds:

a. ICM educational programs and BMPs in wild blueberry management.

b. ICM educational programs and BMPs in cranberry production.

c. The NPS program, the CZM program, and the Generic State Management Plan for Pesticides and Ground Water.

d. SWCDs, with jurisdiction in the seven watersheds, should proactively provide practical, technical assistance, enabling farmers to adopt BMPs that will reduce NPS pollution.

e. The *Hexazinone State Management Plan for the Protection of Ground Water*.

f. DEP and production company efforts to minimize the impact of processing effluent discharges on receiving waters. Also, DEP enforcement of discharge license limitations.

g. Ensure that permits issued for activities in watersheds of Atlantic salmon rivers will result in the maintenance of appropriate habitat for Atlantic salmon. The Atlantic Salmon Authority will be invited to attend all pre-application meetings and review permits for these projects.

h. DEP siting standards and programs for the agricultural use of biosolids.

i. DEP programs that protects surface and groundwater from petroleum product contamination.

Funding

Funding for these programs is already included in the operating budgets of the appropriate state and federal agencies and the agricultural community.

New or Enhanced Programs

The State has begun to focus NPS programs on the Sheepscot River watershed and is developing a watershed-specific NPS plan. The key to resolving conflicts between agricultural practices and Atlantic salmon habitat will be having the farmers, Atlantic salmon biologists, hydrologists, agricultural engineers, local conservation organizations, and environmental regulators work cooperatively and creatively to solve the dynamic problems of NPS pollution and wetlands alteration. The process will include assembling watershed-specific steering committee that will undertake resource inventories, identify problems, and recommend solutions.

AP 2 Nutrients and Sediments

a. Target the Sheepscot River for a watershed-specific NPS program that addresses livestock grazing, manure management, riparian zone management, and other agricultural practices that may be contributing NPS pollution.

b. Seek funding sources to develop, coordinate, and implement a watershed- specific NPS program on the Sheepscot River.

c. Monitor the effectiveness of education and technical assistance programs that persuade farmers to voluntarily adopt BMPs.

d. Conduct an embeddedness survey and a sedimentation monitoring program to determine the effectiveness of BMPs in restoring or maintaining productive Atlantic salmon habitat.

e. The Atlantic Salmon Authority staff should participate in educational programs related to biosolids.

Funding

Existing NPS grants and programs are not targeted for the Sheepscot River watershed. Therefore new funds will be required to expand these programs, to provide technical assistance to farmers, and to study the effectiveness of BMPs. Additional funds needed are estimated at $30,000 per year.

AP 3 Wetlands Inventory

Conduct a resource inventory of wetlands with water quality benefits in Atlantic salmon watersheds. The inventory would review existing wetland maps and identify wetlands and the specific functions important to the integrity of Atlantic salmon habitat. These wetlands should be protected from future agricultural activities that would eliminate the important functions identified.

Funding

Maps and values from previous wetland inventories may be available that could expedite this action. These sources need to be assembled and reviewed. It may be necessary to visit some of the highest value wetlands. A number of state agencies are capable of completing this assessment. The agency responsible for inventories will vary with watershed.

Pesticides

The Agricultural and Forestry Work Groups believe that strict compliance with existing regulations and responsiveness to complaints will result in comprehensive protection of Atlantic salmon and its habitat from the impacts of pesticides. These Groups support the following action:

AP 4 Enhance Board of Pesticides Control (BPC) programs which evaluate and mitigate the threats to Atlantic salmon associated with pesticide use. The following tasks are necessary to complete this action:

a. The BPC will need to consult with the Departments of Agriculture, Food and Rural Resources, Conservation, Environmental Protection, Inland Fisheries and Wildlife, Marine Resources, Atlantic Salmon Authority, University of Maine Cooperative Extension, U.S. Fish and Wildlife Service and U.S. Natural Resources Conservation Service in order to identify resources for an environmental toxicologist. These groups will work cooperatively with the toxicologist to evaluate toxicity and exposure data as it becomes available.

b. Cooperatively undertake a systematic review of all pesticides being used in the seven river watersheds.

c. Work closely with the agencies identified above to secure funding and establish a pesticides monitoring program for those pesticides that are determined to be potential threats in the watersheds.

d. Work to ensure that BMPs are developed for the pesticides used in the target watersheds. The BMPs will be updated annually, based upon the latest research, and training. Updated versions of the BMPs will be made available to all pesticide users working in the seven river watersheds.

e. Respond to documentation of adverse effects to Atlantic Salmon or their habitat being caused by pesticide use by proposing modifications to current regulations and by revising product registration status.

Funding

This is a dynamic action with several tasks. An aquatic risk assessment for all the pesticides, currently used in Atlantic salmon watersheds, is required. The cost of this risk assessment depends on the whether funds will be needed for an environmental toxicologist or if the state or federal government can provide these services. The cost of a monitoring program can only be estimated after pesticide risk has been determined. Developing BMPs and amending regulations are tasks which are funded from operating budgets of appropriate agencies.

AP 5 Pesticides Research - Hexazinone

The following research is proposed if the pesticide risk assessment identifies current concerns about chronic sublethal exposure of Atlantic salmon to hexazinone as a priority.

Determine if minimal hexazinone exposure has any sublethal or chronic effects on salmon development. National Biological Service researchers have expressed interest in examining the potential for hexazinone to affect the Atlantic salmon endocrine system.

MONITORING

AP 6 Pesticides

The Maine Blueberry Advisory Committee annually funds $5,000 for monitoring hexazinone levels in groundwater.

AP 7 Direct Discharges

Monitoring reports on BOD, temperature, and TSS in berry processing plant discharges are required monthly by DEP as part of permits issued. Companies that own berry processing plants are responsible for compliance monitoring.

ALTERNATIVES

The watershed-specific approach to resolving conflicts between agricultural practices and Atlantic salmon habitat presented in this section of the Conservation Plan are the result of considering three major alternatives:

1. Eliminate agriculture from all Atlantic salmon watersheds.

2. Continue agriculture at its current level, allowing no expansion in Atlantic salmon watersheds.

3. Continue agriculture at its current level and allow expansion in Atlantic salmon watersheds.

There is no evidence that the agricultural activity in the seven rivers have contributed significantly to the current low populations of Atlantic salmon. Therefore, alternatives one and two seem unwarranted, especially in light of the significant impact that they would have on Maine's economy. The Agricultural Working Group adopted the approach of developing watershed-specific solutions to NPS pollution, wetland alteration, and processing plant discharges, which, by using ICM, IPM, and site-specific BMPs allows agriculture to continue and expand without adverse effects on Atlantic salmon.

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Appendix Number 1, 2, and 3 are currently not available for viewing.

APPENDIX 4: Pesticides

Table 1. Typical products used by Downeast cranberry growers.

Insecticides:	Fungicides:	Herbicides:
Diazinon	Bravo	Roundup
Guthion	Manex	Casoron
Lorsban	Kocide	Devrinol
Sevin	Carbamate	Poast

Table 2. Typical pesticides used by Christmas tree growers.

Insecticides & Miticides:	Herbicides:
diazinon	simazine
chlorpyrifos	atrazine
fluvalinate	oryzalin
permethrin	clopyralid (Stinger)
fenvalerate	glyphosate
dicofol	

APPENDIX 5: Critical Pesticide Control Area

The Dennys River Critical Pesticide Control Area was adopted in 1978 at the request of conservation groups concerned that the extension aerial spray programs to control spruce budworm would harm Atlantic salmon. The designation prohibited aerial applications within one half mile of the river above Gilman Dam and one mile below the dam unless a permit was obtained from the Board. The regulation was not seriously opposed by the Department of conservation or large forest landowners in the area although they pointed out there was no evidence to show chemical residues were having nay impact on the fishery. By the early 1980's, the State was switching to Bt formulations and the program was terminated after 1985. No requests to make aerial applications within the designated are have been received.

The Deblois Fish Hatchery Critical Pesticide Control Area was adopted in 1979 to formalize a 1973 agreement between the Maine Department of Inland Fisheries and Wildlife and blueberry growers with fields adjacent to the tributaries supplying water to the state owned facility. Prior to the agreement, aerial applications of azinphos-methyl to control the blueberry fruitfly had resulted in resides entering the hatchery and causing fish mortality. The prohibition of aerial application within 1,000 feet of the hatchery and its tributaries and the requirement that any ground applications utilized carbaryl prevented further problems. Although the State of Maine no longer operates the facility, blueberry growers have never asked that the regulation be revised or repealed.

In 1989, the Board revised its regulations to establish specific criteria the Board would use in deciding future requests for critical pesticide control area designations. The criteria include areas where pesticide use, without additional restrictions, is likely to cause harm to threatened or endangered species or their habitat. The rule also clarifies that citizens, municipal and county officials and the Board's staff may initiate petitions for rulemaking on a designated site. At this time, the board is not aware of any need for additional protection in the seven watersheds.

Peat Mining

Introduction

Although there are substantial commercial sized peat resources in eastern coastal Maine, few sites are currently exploited. An estimated 770,000 acres of Maine contain 1.8 billion tons of peat in commercial deposits greater than 10-feet deep (Davis and White 1979). Peat mining has occurred at least since the early 1990's (Bustin, E.S. 1909), with as many as 12 different locations being mined in one year (Joan Brooks, Univ. of Maine Civil Engineering, personal communication). Since 1964, four or fewer operations were active in any year (Davis and White 1979).

There are six peat mining sites that currently hold Department of Environmental Protection (DEP) and/or Land Use Regulation Commission (LURC) permits. One is within the Narraguagus River watershed, one of the seven watersheds where Atlantic salmon are proposed for listing under the Endangered Species Act (Table 1). That mine, in Deblois at Denbo Heath, is operated by Worcester Peat Co. The other active peat mining operation, Big Heath in Centerville, is in the Chandler River watershed. Within the last year both agencies have been contacted regarding the opening of a new mine in T18 MD BPP and T25 MD BPP on Brandy Heath. The proposed "pilot project" mine will affect at most 10 acres of the approximately 150-acre bog. Brandy Heath is in the Machias River watershed, very near the watershed boundary with the Pleasant River.

Worcester Peat Co. has been very cooperative in working with State agencies to resolve concerns about potential water quality impacts from their peat mining operation. Worcester Peat Co. believes that it is in its best interest to communicate openly with DEP and LURC regarding their mining of peat from Denbo Heath and the drainage and erosion control system and water quality monitoring program. Some of the problems Worcester Peat Co. faced when they began the construction phase of an erosion control berm system were resolved by the DEP project analyst and engineer. Both DEP and LURC have negotiated a comprehensive water quality sampling plan with Worcester Peat Co. that keeps costs from becoming prohibitive. For these reasons and others it is the philosophy of the management of Worcester Peat Co. to seek the counsel of these agencies on environmental issues. The staff and resources of both agencies have assisted Worcester Peat Co. in complying with the permits and regulations. Worcester Peat Co. is committed to the current process of cooperative problem solving with DEP and LURC.

Table 1. The name, size (acres), location (town and watershed), and status of sites where peat harvest is currently permitted in Maine. The type of township in which a deposit is located; organized (ORG) or unorganized (UNORG) is also noted.

Site Name	Size	Town	Watershed	Status	Type
Big Heath	250	Centerville	Chandler	Active	ORG
Denbo Heath	800	Deblois	Narraguagus	Activie	ORG UNORG
- none -	100	Harrington	Coastal	Inactive	ORG

Jonesport Heath	175	Jonesport	Indian	Inactive	ORG
Great Heath	105	Penobscot	Coastal	Inactive	ORG
The Heath	435	Saco	Saco	Inactive	ORG

* Maine Public Lands is responsible for management of much of The Heath.

Regulation of Peat Mining

The State of Maine recognizes the importance of all its natural resources for sustainable ecosystems as well as a sustainable economy. The State is highly motivated to protect the water quality of all surface waters, including those with significant fisheries. The Maine Legislature has enacted a framework of environmental laws to protect and restore our natural resources and reduce the discharge of pollutants. Examples of new initiatives that show the importance of water quality and environmental protection to the State include the Overboard Discharge Removal Program, and the Maine Environmental Priorities Project.

Environmental regulations in Maine are administered by two agencies; LURC has jurisdiction in the unorganized townships, plantations, and towns. DEP has jurisdiction in organized towns and townships on projects in wetlands in unorganized territories through the Natural Resource Protection Act. The following section reviews the existing regulations for both agencies.

Land Use Regulation Commission (LURC)

A new peat mining operation in LURC's jurisdiction would require a change in zoning and a permit for development. Peat bogs are considered "mineral deposits" under Section 10.02(47), and peat mining is considered "mineral extraction" under Section 10.02(48) of the Commission's regulations. Peat mining requires rezoning to a (D-CI) Commercial Industrial Development Subdistrict. Peat mining is an allowed use within a (D-CI) Commercial Industrial Development Subdistrict upon issuance of a LURC Development Permit under the provisions of Section 10.14,A,3,b(14) of the Commission's regulations.

To be approved, proposed rezonings in LURC's jurisdiction must meet the statutory requirements of 12 MRSA '684-A(8). All LURC permit applications must meet the statutory requirements of 12 MRSA '685-B(4).

Department of Environmental Protection (DEP)

The State laws administered by the DEP that pertain directly to the mining of peat include the Natural Resources Protection Act (38 MRSA '480-A - 480-S), the Site Location of Development Act (38 MRSA '481 - 490), and the Protection and Improvement of Waters Act (38 MRSA '361-A - 452). These laws act together to ensure that the mining of peat with in the state does not have a significant adverse affect on surface water quality. Any peat mining proposal would be subject to the provisions of one or more of these laws. Peat mining was removed from the Site Law by the last legislative session (H.P. 1353 - L.D. 1854 altered 38 MRSA '482 sub 2 and 2B).

Approach to Estimating Threat

At present, the only potential mortality of individual Atlantic salmon resulting from peat mining activities would be caused by changes in water quality on both branches of Narraguagus River below the mine discharges. The discharge of low pH water and water containing suspended peat silt and dissolved metals and pesticides could cause direct mortality of all life stages if concentrations were greater than lethal concentrations. Estimating the amount, extent, and timing of this type of loss would be very difficult. It would require predicting salmon population densities in addition to characteristics of peat mine discharge (probability of permanent erosion control structure failure; concentrations of a variety of ions in the discharge). In effect it would become an exercise in tracking "paper fish." Rather than attempt this, the Agricultural Working Group opted to consider water quality a component of habitat.

Habitat has two components, quantity and quality. Reducing the area of the river (i.e., units 100 m5) that produces Atlantic salmon would represent a direct loss of habitat. In the same way, reducing a given unit's ability to produce Atlantic salmon constitutes threat of habitat. The ability of a unit of habitat to produce Atlantic salmon is rated using models that account for the fish's habitat requirements. These habitat models, conceptualized and promoted by the U.S. Fish and Wildlife Service, assign a rank value of one to optimal conditions (USFWS 1981). By considering water quality a key component of habitat, the threat to Atlantic salmon from peat mining will be tracked based on changes in habitat quality. The effect of changes in habitat quality on a population is mediated by survival and/or altered behavior (Trial 1989). Thus, changes in habitat quality directly reflect changes in carrying capacity for the species. However, because the amount and location of habitat for the species are known for the Narraguagus River, estimating loss of habitat requires only predicting water quality and quantity in the habitat below the peat mine discharges.

Mining in Relation to Atlantic Salmon Habitat

The Narraguagus River system contains 6,021.3 units (100 m^2) of Atlantic salmon juvenile rearing habitat. The mainstem Narraguagus contains 80 percent of the juvenile salmon rearing habitat in the drainage and the West Branch of the Narraguagus has approximately 8 percent. The reminder, 870.3 units of juvenile salmon rearing habitat is on tributaries. Approximately 800 acres of Denbo Heath are currently ditched and 600 acres commercially mined. Denbo Heath is between the West Branch and mainstem Narraguagus Rivers, and both receive runoff from the commercial operation. The northern portion of the site, approximately 400 acres, drains into the West Branch Narraguagus, the southern 300 acres drains into McCoy Brook, a tributary to the mainstem Narraguagus, and 100 acres is probably a groundwater recharge area. Discharge from the commercial operation enters the West Branch Narraguagus within 300 yards of the edge of the bog, upstream of most of salmon habitat in that branch. The West Branch contains a total of 393.8 units of salmon rearing habitat, all downstream of the discharge. The first habitat reach below the discharge contains approximately 133 units of rearing habitat. The discharge from the southern portion of the site exits the bog and flows a short distance to an impoundment called Farm Pond. From there it enters McCoy Brook. The distance between Farm Pond and the mainstem Narraguagus is approximately two miles. There is no Atlantic salmon habitat in McCoy Brook, however, there is salmon rearing and spawning habitat at the mouth of McCoy Brook. The mainstem Narraguagus contains a total of 4,757.2 units of salmon rearing habitat with 1,833.7 units downstream of the discharge. The first reach below the discharge contains approximately 649.8 units of rearing habitat. Downstream of both discharges are long stretches of deadwater habitats that are not considered juvenile salmon rearing habitat, but do provide holding areas for adult salmon residing in the river prior to spawning and kelts during winter.

POTENTIAL THREATS TO ATLANTIC SALMON FROM PEAT MINING

Besides the United States, peat is mined in many European countries and in Canada. Mining in these countries probably overlap the distribution of Atlantic salmon, i.e., Ireland, Sweden, Norway, Finland, The Netherlands, several countries once part of the USSR on both the Baltic and North Atlantic, and Canada. In an on-line literature search of AGRICOLA and ASFA databases there were no references that included both Atlantic salmon and peat. Given the extensive scientific literature related to Atlantic salmon, it seems likely if peat mining had affected Atlantic salmon production there would be some record in the literature. In Canada many peat mining operations are on small coastal drainage that do not support Atlantic salmon (G. Godin, B. Currie; N.B. Department Natural Resources, personal communications). However, operations on the Caraquet River that have the potential to affect Atlantic salmon production have caused no problems (A. Madden N.B. Dept. Natural Resources, personal communication).

Although there is no direct evidence that peat mining in other countries has affected Atlantic Salmon, literature reviews have documented the effects of peat mining on wetlands (Carpenter and Farmer 1981), aquatic resources (Camp Dresser and McKee 1981), water quality (Washburn and Gillis 1982, 1983), and water quality and quantity (Clausen and Brooks 1980). In addition, there are reports on the effects of peat silt on streams in Sweden (Olsson and Naslund 1985) and Ireland (Dodge 1969, Salmon Research Trust of Ireland 1969).

Peat Silt

The effects of peat silt in streams are the same as siltation from mineral sources. Those that relate to Atlantic salmon include degraded spawning and nursery riffles, reduced aquatic insect diversity and production, and the potential for direct mortalities of all life stages and avoidance of water with suspended peat silt. These effects would combine to result in decreased Atlantic salmon production where peat silt was deposited. The magnitude of the effects in a river would depend on the volume of peat silt and the location of the discharge in relation to Atlantic salmon habitat.

Water Quantity

Water storage capacity of peat deposits has a role in regulating streamflow (Damman and French 1987). Unmined deposits are saturated with water most or all of the year, with water stored in the peat, and in pools or snow on the deposits, as well as intercepted water on the vegetation. Storage capacity of the peat is highest in summer when water levels are lowest (Damman and French 1987). Mining alters the normal pattern of water storage and runoff (Camp, Dresser, and McKee 1981). Clearing in preparation for mining reduces transpiration and interception, however, most effects are related to drainage (Brooks and Predmore 1978). The watertable is lowered, with the greatest affect near the ditches. The closer together the ditches are, the lower the resulting watertable. Clausen and Brooks (1980) concluded based on their review of the literature that peatlands drained for mining have increased storage capacity and their watersheds have reduced peak runoff flows, and increased minimum flows compared to undrained peatlands and their watersheds. These changes result in increased annual flows and more evenly distributed runoff throughout the year. For the same rainfall event, although the magnitude of the peak flows were similar, the mined bog had higher streamflow for a shorter period than an unmined bog (Brooks et al. 1982). In the same study, runoff from snowmelt through early summer was a higher percentage of the annual runoff from the mined bog than unmined bog. The effects of hydrologic changes associated with peat mining on brown trout in Sweden were considered minimal (Olsson and Naslund 1985). The effect of changes in hydrology on Atlantic salmon would be related to the ratio of mine to watershed area and the sensitivity of the fish and habitat to predicted changes. Where there is spawning and juvenile habitat below the bog's outlets, increased spring and early summer flows could affect alevin dispersal from redds.

Water Quality

The quality of water within and running off peat deposits is related to the concentration of elements in precipitation (both wet and dry) and terrestrial (soil) water. Soil water is precipitation after it has been in contact and reacted with elements in mineral soil and bedrock (Damman and French 1987). Thus, the content of rain and peat, as it reflects historic precipitation and groundwater exchange, is key in determining peatland water quality (Camp, Dresser, and McKee 1981). Thus, water quality in each bog is somewhat different. The geochemistry of two Maine peat deposits was different, reflecting the plant activity, inputs from ocean aerosols, wind-blown soils, polluted air masses (i.e., industrial air pollution, pesticides, volcanic ash, radiation fall out) and gaseous exchange with the atmosphere (Norton 1990). Washburn and Gillis (1982) included a table of chemical analyses of peat deposits as well as peatland waters. They noted that water in fens (deposits connected to the groundwater) had higher concentrations of nitrogen, phosphorous, potassium, sulfur, calcium, magnesium, iron, boron, copper, and molybdenum than bog waters (isolated from local watertable), which were higher in magnesium and zinc. In general, bog waters (pools and brooks) are intermediate in concentration between precipitation and nearby mineral-based streams for potassium, magnesium, calcium, and iron (Damman and French 1987). Peatland waters are higher in hydrogen ion concentration (lower pH), primarily due to humic and fulvic acids, and lower in alkalinity and hardness than mineral-based streams.

Drained peat mining results in additional inputs of peatland waters into downstream surface waters. Runoff from milled bogs was higher in temperature, specific conductivity, suspended sediments, and concentrations of hydrogen ions, arsenic, and nitrogen (total, ammonia, and organic) than runoff from natural bogs (Clausen and Brooks 1980, Clausen et al. 1982). The Washburn and Gillis (1982) literature review also noted potential for increased color and sodium, aluminum, potassium, iron, zinc, copper, boron, magnesium, bicarbonate, sulfate, and nitrogen concentrations. Mining operations did not increase levels of nickel, lead, cadmium, arsenic, and selenium in runoff. In a Newfoundland study, mining decreased pH, alkalinity, specific conductance, hardness, calcium, and magnesium concentrations and increased turbidity, suspended solids, and nitrate, total organic carbon, and barium concentrations immediately below bog inputs. However, values for all parameters approached normal 1.3 km downstream (Washburn and Gillis 1982). A study in Sweden did not detect elevated runoff concentrations of mercury as a result of peat mining (Westling 1991). The discharge of chemicals from mined bogs is greatest during the first year of operation, with loss of chemicals from the site declining with time (Clausen et al. 1982). Atlantic salmon behavior or survival could be affected by several of the elements that increase in peat mine discharge. The concentrations below the discharge, relative to upstream concentrations, would control the extent and amount of possible mortality.

NARRAGUAGUS RIVER WATERSHED

Description of Peat Mining

Worcester Peat Co. mines peat by the milled peat method, which originates from Ireland. Draining the peat deposit is necessary in the mining operation and Denbo Heath is drained by a perimeter ditch and bay ditches approximately 80 feet apart. Once a bog is cleared and drained, the sun and the wind bring the moisture level of the peat to a suitable range for mining. Milled peat mining is a four-step process: 1) milling, 2) spoon harrowing, 3) ridging, and 4) harvesting. After a section is mined the process starts over again.

Activity on the bog is limited by temperature and snow in winter. Spring water levels also prevent harvest. Ditching usually occurs between late May or early June and the last activity on the bog is in September. The milling machine is similar to a roto-tiller, with very short tines (about one inch) that break up the surface of the bog (1/2 to 3/4 inch). The spoon harrows turn the freshly milled peat to start the drying process. Once the bog has been milled it has to be spooned harrowed at least three times before the moisture content is low enough to mining the peat. When the peat moisture content is approximately 40 to 50 percent, ridging takes place. This step takes the dry peat from the surface and puts in a windrow. The machine is similar to a snow plow. Once the dry peat is windrowed it is ready to be mined. The harvester looks and operates much like a potato harvester. It has a chain head that picks up the ridged windrows of peat, which move down conveyors to a tractor drawn cart. Once the cart is full, the peat goes directly on trucks or is stockpiled for later shipment.

Evaluation of Threat from Peat Mining

Threats in the Narraguagus system will be estimated based on pH and suspended solids in the West Branch associated with discharges from the Denbo Heath peat mine. The evaluation will be based on the amount and extent to which habitat has been and is likely to be affected by peat mining. The habitat suitability model for juvenile Atlantic salmon (Stanley and Trial 1995) will be used to quantify changes in habitat quality.

<u>Peat Silt</u>

In the Narraguagus River, mine discharge on the mainstem influences a much shorter length of river than the discharge on the West Branch, but with the potential to affect a greater amount of habitat. The sediment trapping capacity of Farm Pond and McCoy Brook has the potential to reduce the probability of direct sedimentation of the mainstem. Movement of peat silt in discharge waters and its effects can be prevented with adequately designed sediment traps on the outlets of mining operations (Javinen and Aho 1985). There is no indication of long-term habitat quality loss due to peat silt. Substrate evaluations in juvenile rearing habitat below the mine on both the West Branch and mainstem Narraguagus have not noted significant buildup of peat silt. Sampling following a peat silt event found diverse and functioning invertebrate communities on the mainstem Narraguagus. Additional invertebrate sampling confirmed that peat silt had not affected communities (Siebenmann 1995).

In April 1993, Farm Pond Dam failed during a storm/high water event and released large quantities of peat into McCoy Brook. Peat was also deposited on the banks of the mainstem Narraguagus. Water turbidity was 62 NTU in McCoy Brook and 14 NTU at the confluence with the Narraguagus. The discharge increased turbidity in the mainstem from 0.6 NTU to 2.4 NTU. The Atlantic Salmon Authority (ASA) staff has periodically observed peat along the banks of the West Branch. During August 1991, floating mats of peat were seen in small backwater pools along the river, within a few miles downstream of the discharge. These mats of peat were not observed in the lower West Branch or anywhere along the mainstem. Suspended solids in the West Branch were 11.2 mg/l at about the same time. The highest suspended solids reported in the West Branch below Denbo Heath was 21 mg/l associated with a storm event before temporary erosion-control measures were installed.

Movement of peat silt has occurred to both the mainstem and West Branch of the Narraguagus. These events tended to be in the spring, while the bog was frozen and runoff was high. The sediment catchment capacity of Farm Pond and McCoy Brook reduced the likelihood of direct sedimentation of the mainstem, while discharge from the mine goes directly into the West Branch. During normal river flows (not storm events) suspended solids are less than 10 mg/l and turbidity is less than 3 NTU in both branches. Maximum levels reported during storm events were: suspended solids in the West Branch below Denbo Heath, 21 mg/l and turbidity of 62 NTU in McCoy Brook and 14 NTU near the confluence with the Narraguagus. This discharge increased turbidity in the mainstem from 0.6 NTU to 2.4 NTU. Rivers and streams are suitable for Atlantic salmon as long as ambient turbidity is less than 40 NTU (Stanley and Trial 1995). Suspended sediments in excess of 90 mg/l damage gills and kill salmon, and waters with 25 to 80 mg/l suspended solids will not support fisheries (Gibson 1993). Thus, documented peat silt discharges into the West Branch and mainstem Narraguagus were not sufficient to reduce habitat suitability (Stanley and Trial 1995) or cause direct mortality (Gibson 1993).

Permanent erosion control structures at the Denbo Heath Mine were effective during all storm events in winter and spring 1996. Several of the storms were high volume, high intensity storms. The berm system seems capable of preventing peat silt events in both McCoy Brook and the West Branch of the Narraguagus. Thus, loss of habitat due to peat silt will not occur unless these structures fail. Worcester Peat Co.'s commitment to maintaining the structures will minimize the likelihood of berm failures.

Water Quantity

Because the Denbo Heath mine affects only 800 acres (1.25 mi^2) of the 227 mi^2 Narraguagus watershed, the hydrologic effects of mining are probably minimal. Thus, any hydrologic changes due to the peat mine would have a minimal chance of either adversely affecting or improving Atlantic salmon habitat. Although the emergence and dispersal of aelvins from spawning habitat at the mouth of McCoy Brook could be effected by increased spring runoff, the storage capacity of erosion control structures will mitigate this effect in comparison to a direct discharge. The overall hydrologic effect of mining a bog (reducing peak runoff flows and increasing minimum flows, resulting in more evenly distributed runoff throughout the year) would benefit Atlantic salmon production (Havey and Davis 1970, Havey 1974).

Water Quality

The effects of the additional inputs from drained/mined bogs on the chemistry of the receiving water depend on the chemistry of the receiving waters. With alkalinities in downeast waters, usually less than 20 ppm (Mairs 1966), it is likely that decreases in pH will occur below peat mine drainage outfalls. The effects of peat mine discharge in Maine on concentrations of minerals, metals, and nutrients in the receiving water would probably be site-specific because of differences among bog geochemistry.

pH.

Both the Narraguagus and Pleasant Rivers have bogs in their watersheds, yet mining affects only one drainage. The Atlantic Salmon Authority (ASA) conducted an intensive pH monitoring program in the Narraguagus River drainage and the Pleasant River between the spring of 1990 and the winter of 1993 (Beland et al. 1993; Beland et al. 1994). A comparison of pH in the West Branch Narraguagus River above and below Denbo Heath with that in the mainstem Narraguagus and in the Pleasant River above and below the Great Heath may detect effects of peat mine discharge.

An initial comparison was made among the Pleasant River, and the mainstem and West Branch of the Narraguagus River using pH maxima and minima for 1990-1993 (Figure 1). On the mainstem Narraguagus pH remained above 5.0 throughout all sampling periods. The mainstem usually had a pH of 6.3 $\pm$ 0.5, while the West Branch pH was typically between 5.5 and 5.8 (Figure 1). On the West Branch, pH dropped below 5.0 during storm events, while the mainstem stayed above pH 5.0. The pH at Crebo Crossing dropped below 5.0 in 1993 only, while the pH at Saco Falls was below 5.0 in both 1992 and

1993. The lower pH events on the West Branch and Pleasant River are probably the consequence of multiple factors, including atmospheric fallout, and soil and water chemistry within the watershed (Haines et al. 1990).

During the winter of 1993, ASA monitoring of pH upstream and downstream of the peat mine discharge found significantly lower pH at the downstream site. In the spring, pH in the West Branch below Denbo Heath was significantly lower during storm and runoff events than the pH above the mine discharge. The discharge from Denbo Heath locally depresses pH in the West Branch. In 1993, the pH at Crebo Crossing upstream of the Great Heath on the Pleasant River, was significantly higher than the pH at Saco Falls, downstream of the Great Heath. The discharge from unmined Great Heath also locally depresses pH in the Pleasant River (Figure 1). The effects of the two bogs on river pH, although related to alkalinity of the receiving water, seems to be of similar magnitude.

Figure 1. Annual maximum and minimum pH for sites on the Narraguagus and Pleasant Rivers. ***(Figure 1. currently not available for viewing).***

Episodes of pH below 5.5 may cause salmonid emigration or mortality, depending on Al concentrations (Haines et al. 1990). Gagen et al. (1993) found brook trout mortalities of 43 to 10 percent in streams with episodic low pH (between 5.5 and 5.O), elevated total Al (> 124 ug/L), and low dissolved organic carbon (< 5.0 mg/L). Acid-tolerant populations of Atlantic salmon, brook trout, and arctic charr are known for bog drainage in Nova Scotia and Newfoundland (Clarke-Whistler et al 1984). The waters of the Narraguagus and the Pleasant are highly colored with dissolved organic carbon compounds that bind the aluminum, making it unavailable for biological activity. Given the levels of measured aluminum at less than 95 ug/L and the high dissolved organic carbon in the Narraguagus River (Beland et al. 1992), pH levels above 5.0 are considered suitable to sustain populations of Atlantic salmon. Salmon habitat is unsuitable if pH episodes below 4.0 occur (Stanley and Trial 1995).

Discharge from the mined bog locally depresses pH in the West Branch. The site below the peat mine has lower pH during storm runoff events than sites above. Sites on the West Branch above and below Denbo Heath and on the Pleasant River above and below Great Heath all have annual pH profiles lower than that in the mainstem Narraguagus (Figure 2). Assuming that unaffected habitat has a suitability value of one, then one minus the suitability value of affected habitat is an estimate of loss of habitat quality. Habitat suitability would be 0.40 for the river above and below the mine discharge because pH was between 4.0 and 5.5 at least once annually (Stanley and Trial 1995) based on annual pH profiles for the early 1990's (Figure 1). Based on ASA data and other data for the Narraguagus River, it is probable that pH in the West Branch will be below 5.0 at least once annually every year. There is no evidence to indicate that pH on the mainstem Narraguagus has fallen below 5.0 in the past nor any predictable reason to expect 5.0 or lower pH events in the future. Thus, there has been no loss of habitat related to the effects of mine discharge on pH in either branch of the Narraguagus. If pH below the mine discharge was 4.0 or below at some time during the year (suitability of 0.05) there would be a significant reduction in habitat quality. Only then would there be a reduction in carrying capacity. However, we have no way to predict the frequency of such an event, as there is no record of it having occurred in either branch.

Other Water Quality Data. The environmental permits associated with the peat mining operation on Denbo Heath have required water quality monitoring. The monitoring plan requires grab water samples to be taken annually, during the spring and fall. Samples were taken from above and below the discharges on the mainstem Narraguagus and the West Branch, plus at the outlet of Farm Pond on McCoy Brook. Temperature, conductivity, pH, alkalinity, BOD, total and suspended solids, nitrogen and concentrations of aluminum, copper, iron, nickel, lead and zinc, total phosphorous and dissolved oxygen, were reported by Down East Peat, LP in 1993. The list of water quality parameters changed from year to year in the Down East Peat, LP water quality reports (1988 to 1992). Data on suspended solids are available for several rainfall events in 1990 and 1991, as are turbidity and total organic carbon concentrations for several dates in 1993. Additional water quality data for different stretches of the Narraguagus River are available from U.S. Geological Survey (USGS) records; Borns, Dimond, and Norton (1980); Taylor (1973); Haines and Akielaszek 1984), and ASA and DEP files.

Other components of the discharge may be a threat to Atlantic salmon. The Agricultural Working Group is initiating an analysis of these data to assess the potential for mortality.

MACHIAS RIVER WATERSHED

DEP or LURC have received a permit application for a new peat mine in the Machias watershed.

EAST MACHIAS, DENNYS, SHEEPSCOT AND DUCKTRAP RIVER WATERSHEDS

There are no active peat mines in any of these watersheds.

ACTION

Improve Permit Reviews and Standards

Environmental regulations in Maine are administered by LURC in the unorganized townships, plantations, and towns and DEP in organized towns and townships. Through the Natural Resource Protection Act, DEP also has jurisdiction on projects in wetlands in unorganized territories. Both agencies are currently attempting to consolidate regulatory responsibility for development in wetlands in LURC territories.

PM 1 In 1989, peat silt from the Denbo Heath mine entered the West Branch and McCoy Brook because erosion control at the site was inadequate. Erosion control requirements on the permits were not complete, in part because agency staff was not trained to deal with the unique problems associated with peat mining. Because the current set of guidelines and standards for peat mining permits seems to have contributed to these problems, they need to be reviewed and updated to ensure Atlantic salmon habitat is protected. In addition, until agency responsibilities are consolidated, application and permit requirements for both agencies need to be consistent. The following actions are intended to accomplish these goals:

1. Develop guidelines for peat mining permit application reviews for DEP and LURC staff. A team of DEP and LURC staff members will review and revise guidelines.

2. Develop standards for erosion control and settling basins for peat mines. A team of qualified engineers and/or erosion control specialists will review the literature, evaluate erosion control methods used at peat mines, and develop and/or revise standards to be included as permit conditions.

Funding

Estimated cost for these actions will be absorbed by DEP and LURC operational budgets.

Extensive Review of Proposed Mine

PM 2 In the interim, the permit application for a 10-acre "pilot project" peat mine in T18 MD BPP and T25 MD BPP on Brandy Heath will be reviewed by the members of this subcommittee. The review ensures that permit requirements and standards for developing the mine adequately protect Atlantic salmon habitat in the Machias River watershed.

Funding

Permit review is currently part of IF&W, ASA, DEP, and LURC operational budgets.

Estimate Threat Associated with Changes in Water Quality

PM 3

1. Compile and analyze existing water quality data from the Denbo Heath area in relation to Atlantic salmon survival and behavior. Available water quality data for the Narraguagus River will be entered into a database. This data will be analyzed by K. Carr, with the Fish and Wildlife Service in Concord, NH for the effects of different concentrations on Atlantic salmon survival and behavior. Possible outcomes include:

a. Existing data are incomplete: Gather additional water quality data and reevaluate peat mine water quality. This would require funding.

b. Existing data are complete: Use the evaluation to address allowable discharge from peat mines to Atlantic salmon rivers and develop standards for acceptable discharge water quality from peat mines into A and AA waters and protocols for water quality monitoring that will apply to all new peat mines.

(1) Threat unlikely: Monitor peat mine discharge using protocols.

(2) Threat likely: Develop strategies for eliminating chemicals in discharge that are identified as having concentrations toxic to Atlantic salmon.

2. Develop a method to relate turbidity and suspended solids data for peat silt.

Funding

Estimated cost for the initial actions, building a water quality database for the Narraguagus River and relating turbidity to suspended solids will be absorbed by ASA, IF&W, DEP, and LURC operational budgets. The analysis of water quality data for potential threat of Atlantic salmon will be absorbed by the Fish and Wildlife Service, Concord, NH operational budget. Should actions be required to collect additional water quality data or developing mitigation strategies, cost estimates and funding sources will be developed at that time.

MONITORING

PM 4 Permit Compliance

The DEP and/or LURC have been active in field investigations at the Denbo Heath mine (Appendix 1), and are working to ensure that peat mining does not result in reduced water quality. Agency activities have involved regulating mining and associated activities. The site was first reviewed under the Site Law in 1977. In the mid to late 1980's Down East Peat Co. built a power plant with the intent of using peat from Denbo Heath on the Narraguagus River for fuel. Down East Peat continued to expand the bog, without attempting to mitigate the potential erosion problem they had created. In the spring of 1989 there was a discharge of peat into and along the West Branch of the Narraguagus and into McCoy Brook. As a result of a consent agreement between Down East Peat and the regulatory agencies, temporary erosion control was placed on the site. Permanent plans to prevent similar events were being developed when Morrill Worcester bought the operation in January 1993. Worcester Peat Co. assumed the responsibility of implementing a permanent erosion control plan. In October 1994, they began construction of a six-pond drainage system. The system, completed in 1995, is designed to contain the stormwater for short periods of time allowing any peat silt to settle, while discharging the water slowly. The plan, approved by DEP and LURC, was developed by Worcester Peat Co. with their assistance. Site visits by both agencies as well as ASA will continue to evaluate the erosion control system and monitor other permit requirements.

PM 5 Water Quality Monitoring

The DEP and LURC have reviewed submissions for water quality monitoring in compliance with conditions of the order approving the erosion control plan. The proposed new water quality monitoring plan includes both baseflow sampling and storm-event sampling. Baseflow sampling would be done four times per year, with one sampling for each season. Baseflow sampling would be done at the outlets of three of the settling ponds; the West Branch and East Branch of the Narraguagus River, both upstream and downstream of the discharge points; and McCoy Brook. Samples will be analyzed for pH, alkalinity, color, conductivity, temperature, dissolved oxygen, turbidity, iron, and total suspended solids.

Two storm events per year would be sampled: one event under saturated bog conditions in the spring, and one event under relatively dry bog conditions in late summer. During the storm event, hydrographs would be developed for three of the settling ponds, with water quality being sampled at the pond outlets and the river sampling points. Sampling during storm events will be analyzed for the same parameters as baseflow samples, with the exception of iron.

Results from sampling will be submitted to LURC and DEP on a regular basis. An annual report, including a summary and analysis of the data, will also be submitted to LURC and DEP. This revision of the water quality monitoring plan will be assessed after two years of operation. The data generated from this program will be used to establish the most appropriate sampling frequency, timing, parameters, and sites for a long-term water quality monitoring program for the bog.

Funding

Cooperative efforts by Worcester Peat Co., DEP, and LURC are monitoring the ability of the new permanent erosion controls at the mine to effectively protect water quality. Worcester Peat Co. has financial responsibility for maintaining the erosion control system and collecting and analyzing water samples. Funding for compliance visits, cooperative problem solving, and evaluating water quality monitoring is part of normal operating budgets of DEP and LURC.

ALTERNATIVES

The tasks presented in this section of the Conservation Plan are the result of considering three major alternatives:

1. Eliminate peat mining from all Atlantic salmon watersheds.

2. Continue peat mining as it currently exists, allowing no new mines in Atlantic salmon watersheds.

3. Continue peat mining as it currently exists, allowing new mines in Atlantic salmon watersheds.

Based on the potential threats to Atlantic salmon detailed in this report, it seemed unwarranted to pursue the first alternative or to forbid new peat mining in Atlantic salmon watersheds. Laws and regulations administered by DEP and LURC, and their permitting processes minimize the potential threats of water quality and hydrologic alterations on Atlantic salmon habitat. However, in the past, permitting of a peat mine did not necessarily addressed water quality issues at the onset of a project. At Denbo Heath, it took several years for effective erosion control to be developed. The delay experienced in minimizing risks to habitat would currently be unacceptable, given the status of Atlantic salmon populations. Therefore, the Agricultural Working Group included tasks in this plan that increase the awareness of Atlantic salmon issues among regulatory staff, increase the ability of the permitting process to address Atlantic salmon water quality issues when a project is first permitted, and set standards or protocols for erosion control and water quality monitoring that will apply to all peat mines.

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APPENDIX 1: REGULATORY ACTIVITIES AT ACTIVE PEAT MINES

The only two active peat mines are in the downeast region of the state. The DEP and/or LURC have been active in field investigations at these sites, and are working to ensure that peat mining does not result in reduced water quality. Agency activities have involved regulating mining and associated activities at Denbo Heath in Deblois. The site was first reviewed under the Site Law in 1977 (Table 1). In the mid to late 1980's Down East Peat Co. built a power plant with the intent of using peat from Denbo Heath on the Narraguagus River for fuel. Down East Peat continued to expand the bog, without attempting to mitigate the potential erosion problem they had created. In the spring of 1989 there was a discharge of peat into and along the West Branch of the Narraguagus and into McCoy Brook. As a result of a consent agreement between Down East Peat and the regulatory agencies, temporary erosion control was placed on the site. Permanent plans to prevent similar events were being developed when Morrill Worcester bought the operation in January 1993. Worcester Peat Co. assumed the responsibility of implementing a permanent erosion control plan. In October 1994, they began construction of a six-pond drainage system. The system is designed to contain the stormwater for short periods of time allowing any peat silt to settle, while discharging the water slowly. The plan, approved by DEP and LURC, was developed by Worcester Peat Co. with their assistance. There is also a water quality monitoring program associated with the permits issued at the site.

Table 1: A brief history of the Denbo Heath Peat Mine, including permit and regulatory activities of LURC and DEP since 1977.

YEAR	EVENT
1929	Mapping and inventory
1932	Opened for peat harvest
1977	1977 In Board (Board of Environmental Protection) Order #04/14-3489-29180 dated 4/27/77, the Board approved the reestablishment of an 800-acre peat moss mining operation on Denbo Heath. This conditional approval allowed the harvesting of peat using the milled/vacuum process, and the sale of peat for horticultural purposes. Harvesting would continue until the working area was at the same elevation as the surrounding bog - approximate elevation 200.0 msl. Reclamation included filling the manmade ditches with peat and allowing nature to reestablish vegetation on the site. LURC Development Permit DP 3164, issued to Down East Peat, L.P. in August of 1977, allowed Down East Peat to reestablish peat mining, for packaging and agricultural uses, from approximately 400 acres of the Denbo Heath located in T16 MD BPP. The total area of the operation is 1,000 acres, with 600 acres located in the Town of Deblois.
1985	In Board Order #L-003489-24/14-A-A dated 8/22/85, the Board approved the construction of a 12 megawatt electrical co-generation facility on Denbo Heath and a change to the method of peat harvesting from the milled/vacuum method to the sod extrusion method. The Board Order states that half the peat will be pelletized and stored to be consumed by industrial sales and the power generation plant in the winter. The other half will be burned to generate steam.
1989	In DEP Order #L-003489-24/14-E-M dated 12/3/89, the DEP approved the following changes to the Down East Peat facility: an increase in generation capacity from 12 megawatts to 25.8 megawatts, an increase of 3,225 square feet to the power house, a third boiler and stack, use of wood biomass as a backup fuel source, use of 30-acre area for peat wood and biomass storage, amendments to the ash disposal contract, and a revised cost estimate. This order specifies that up to one half of the fuel requirements of the plant may be met with wood biomass.

1989	In DEP Order #L-003489-24/14-H-A dated 2/13/89, the DEP approved an after-the-fact application submitted by Down East Peat L.P. including changes to the site layout, peat and wood chip storage area, drainage and erosion control, ash handling, water quality protection, stump and brush disposal, wastewater disposal, and water supply. Condition #7 of this order states "Residence time of wood chip fuel on the peat stockpile area shall not exceed 90 days. A three-foot thick peat liner shall be placed under the chips. The applicant shall submit plans for review and approval for chip storage if chip storage exceeds a 40-day fuel supply (about 120,000 cubic yards)." On June 15, 1989, DEP staff investigated a complaint of peat washing into the West Branch of the Narraguagus River. Staff found that peat had been discharged into the West Branch of the Narraguagus River and into McCoy Brook, a tributary to the mainstem of the Narraguagus River. In accordance with an Administrative Consent Agreement and Enforcement Order between Peat Products of America, Inc., the Board of Environmental Protection, the Maine Land Use Regulation Commission, and the State of Maine, Down East Peat installed, inspected, and maintained temporary erosion control measures in the flow areas.
1990	DEP Order #L-003489-24/14-L-M dated 5/1/90 approved a change in the peat harvesting method from the sod extrusion method to the milled/windrow method.
1990	A Consent Agreement and Enforcement Order concerning the 1989 violation was signed by the LURC, DEP, and Down East Peat. The Order stipulated that all erosion control structures be checked and maintained on a regular basis. The Order also required monthly, and storm event, water sampling of the West Branch and McCoy Brook.
1991	During an August survey trip on the West Branch ASA staff observed floating mats of peat in small backwater pools along the river, within a few miles downstream of the discharge. These mats of peat were not observed in the lower West Branch or anywhere along the mainstem.
1992	Worcester Peat Co. acquired Down East Peat's operation in December of 1992.
1993	In April, 1993 Farm Pond Dam blew out during a storm/high water event and released large quantities of peat, that still persist, into McCoy Brook. Peat was also deposited on the banks of the mainstem Narraguagus. Turbidity measurements in McCoy Brook quantified the severity of the discharge. DEP Orders #L-003489-14-N-T dated 5/4/93 approved the transfer of permits for the peat harvest operation from Down East Peat, L.P. to Worcester Peat Company, Inc., and the co-generation facility from Down East Peat, L.P. to Worcester Energy Company. LURC Development Permit DP 3164 and subsequent amendments were transferred to Worcester Peat Co. A condition of this transfer stipulated that Worcester Peat submit a revised drainage plan to the Commission to provide for permanent erosion and sedimentation control. DEP sampled macroinvertebrates in the summer of 1993 on the mainstem and McCoy Brook to document water quality impacts the effects of peat silt and any effects of peat silt.
1993	

	DEP Orders #L-003489-14-M-A to Worcester Peat Company and Worcester Energy Company, Inc. dated 7/93 approved minor revisions to the plant facility, fuel supply, and drainage ditches, as well as a reclamation pilot study. DEP Order #L-003489-14-O-M dated 8/4/93 approved construction of a loading ramp for the peat harvest operation.
1994	DEP Order #L-003489-14-P-A dated 8/4/94 approved a voluntary proposal submitted by Worcester Peat for the construction of a revised peat mine drainage plan. The plan includes the construction of several sedimentation ponds designed to settle peat and other sediments from mine runoff before discharge off site. These ponds have now been constructed. Conditions on this permit required submission of a revised water quality monitoring plan and bog operation plan. The revised drainage plan, including the construction of on-bog settling ponds, was approved by LURC in July. A condition of this approval required that Worcester Peat submit a revised water quality monitoring plan and bog maintenance manual to LURC for review and approval. These have been submitted to LURC, and are currently pending.

SCHEDULES FOR IMPLEMENTING ACTIONS ON EACH WATERSHED

WATER USE

Pleasant, Narraguagus and Machias River Watersheds

Water use for irrigating blueberries in the Pleasant River watershed was rated as a high priority by the Agriculture Working Group and as moderate priority in the Narraguagus and Machias River watersheds. The primary action identified was to develop and implement a Total Water Use Management Plan for the watersheds with the goal of meeting the needs of both the Atlantic salmon and agriculture (Tables 2.1, 2.2, 2.3).

Preliminary Total Water Use Management Plans were initiated for the Pleasant and Narraguagus Rivers by the Natural Resources Conservation Service (NRCS), a federal agency, in April of 1996. These preliminary plans will provide the Pleasant and Narraguagus River Watershed Steering Committees with the necessary information to focus available resources on developing Total Watershed Management Plans by January of 1998. These plans will provide specific management recommendations and options to meet the water needs of both salmon and agriculture and estimate the costs of reaching the goal. Implementing recommendation should begin in 1998. In the interim, a group of federal and state agency staff are working with irrigators to insure that present expansion considers the needs of Atlantic salmon.

East Machias, Dennys, Sheepscot, and Ducktrap River Watersheds

Water use was not an issue on the East Machias, Dennys, Sheepscot and Ducktrap River Watersheds as there is little irrigation from these rivers or their tributaries (Tables 2.4-2.7).

AGRICULTURAL PRACTICES

Nonpoint Source Pollution

<u>Nutrients and Sediments</u>

Dennys, Ducktrap, East Machias, Machias, Narraguagus, Pleasant River Watersheds

Nonpoint source pollution was rated as a low priority for these watersheds because existing management practices are effective in controlling NPS pollution (Tables 2.1, 2.2, 2.3, 2.5, 2.6, 2.7). Examples of activities addressed include: tilling, farm road building, livestock management, nutrient management, and erosion control.

Sheepscot River Watershed

Nonpoint source pollution was rated as a high priority in the Sheepscot River watershed (Tables Section Table 2.4). A watershed-specific NPS plan addressing agricultural related nonpoint source issues will be developed and implemented. Critical Atlantic salmon habitat influenced by agricultural activities will be identified. Land uses will be inventoried with specific activities that have the potential to degrade water quality identified and action steps developed and implemented. Planning activities will start in May of 1996. Since Best Management Practices (BMPs), education, technical assistance, and regulatory mechanisms exist for most agricultural nonpoint source issues, implementation of programs will occur in conjunction with the development of the Nonpoint Source Total Watershed Management Plan.

<u>Pesticides</u>

Pleasant, Narraguagus, Machias, East Machias, Dennys River Watersheds

Pesticide use issues were rated as a moderate priority in the Pleasant, Narraguagus, Machias, East Machias, and Dennys River watersheds due to the agricultural activity in these areas (Tables 2.1-2.4, 2.5-2.6). However, the level of threat to Atlantic salmon is considered low because comprehensive programs are in place.

Pesticide use is regulated and monitored by the Board of Pesticides Control (BPC). Targeted Integrated Pest Management (IPM) programs focused on blueberries and cranberries will continue with the support and direction of University of Maine Cooperative Extension (UMCE), BPC, the local Soil and Water Conservation Districts (SWCDs) and Natural Resources Conservation Service (NRCS). Additionally, the implementation of the Hexazinone State Management Plan for the protection of groundwater will be monitored by the BPC with support from UMCE and the blueberry industry.

Ducktrap and Sheepscot River Watersheds

Pesticide use issues were rated as a low priority in the Ducktrap and Sheepscot River watershed because of limited use and/or existing regulatory and educational programs (Tables 2.4 and 2.7).

Pesticide use is regulated and monitored by the BPC. IPM programs focused on Christmas trees and corn production will continue along the Sheepscot River.

<u>Oil, Fuel, and Contaminant Management</u>

All Watersheds

Best Management Practices for the handling of oil, fuels, and other potential contaminates are in place (Tables 2.1-2.7). Additionally, the Department of Environmental Protection has spill teams ready to respond to accidental spills. Because adequate programs are in place, the Agricultural Working Group rated the issue as low priority.

Wetland Alteration

All Watersheds

Wetland alterations are regulated by the Department of Environmental Protection (DEP), Land Use Regulation Commission (LURC), Army Corps of Engineers, and local ordinances (Agricultural Practices Appendix 2). Because wetlands are regulated comprehensively in Maine, the Agricultural Working Group rated the issue as a low priority. Ongoing actions focus on continued education and compliance with current regulations. High value wetlands that contribute to Atlantic salmon habitat will be identified (Tables 2.1-2.7).

PEAT MINING

Narraguagus and Machias River Watersheds

There is an active peat mine in the Narraguagus River watershed and a proposed mine in the Machias River watershed. Actions to assess and minimize the effects of both are proposed (Tables 2.2 and 2.3).

Table 2.1. Pleasant River: Schedule for implementing actions that will reduce threat to Atlantic salmon habitat from agricultural activities and promote recovery of Atlantic salmon populations.

Watershed: PLEASANT RIVER Director of implementation: Pleasant River Watershed Steering Committee								
TASK CODE	**PRIORITY**	**ACTIVITY**	**ACTION TO REDUCE THREATS AND PROMOTE RECOVERY**	**ACTION FEASIBILITY**	**TIME PERIOD**	**RESPONSIBILITY .LEAD in CAPS .cooperators in lower case**	**RESOURCES .Existing .New .Annual**	**ESTIMATED NEW FUNDING**
WU2	High	Water Use	Develop Total Water Use Management Plan. adopt total water management plan pproach establish watershed council report preliminary plan to water use working group	High	3/96-8/96 Done 5/96 11/96	NRCS/asa,dafrr, dep,hug,if&w, lurc,usfws ASTF LWRC NRCS	E	0
WU2	High	Water Use	Develop best alternatives from Total Water Use Management Plan.	High	9/96-1/98	NRCS/asa,dep, dafrr,dep,hug, if&w,lurc,usfws	E $200,000** $300,000	0
WU3	High	Water Use	Seek funds to implement Total Water Use Management Plan.	To be determined	98-08	LWRC	N	to be deter- mined
WU1	High	Water Use	Voluntary reduction of water withdrawal in area of highly valued salmon habitat.	High	6/96	HUG/asa	E	0
WU1	High	Water Use	Review proposals for new cranberry bog and irrigation impoundment.	High	Ongoing	DEP/lurc,asa, if&w	E	0
WU4	High	Water Use	Request USGS to reestablish gaging station.	High	7	WRC	N	to be deter- mined
AP4	Moderate	Pesticide Use General	Enhance monitoring and regulatory activities of Board of Pesticides Control.	High	Ongoing	BPC	E	0
AP1	Moderate	Pesticide Use Target Crops	Target ICM educational programs and promote use of BMPs on blueberries and cranberries.	High	Ongoing	UMCE/bpc,swcd, nrcs	E,A $3,000	0
AP1 AP6	Moderate	Hexazinone Use	Implement Hexazinone State Management Plan for the Protection of Groundwater and monitor effectiveness of BMPs.	High	Ongoing	BPC/umce,growers	A	0

							$1,000	
AP5	Moderate	Hexazinone use	Determine if hexazinone exposure has sublethal or chronic effects on Atlantic salmon.	High	99	ASA/usfws	N	60,000
AP1	Low	Agricultural Practices	Implement proactive NPS and technical assistance programs to assist growers in adopting applicable practices (BMPs) and monitor effectiveness.	High	97 + 98	SWCD/nrcs,umce, dafrr	N	$20,000 /2 years
AP1	Low	Biosolids Utilization	Maintain DEP siting standards and have ASA review permit applications.	High	Ongoing	ASA/dep	E	0
AP3	Low	Wetlands Alteration	Develop inventory of high value wetlands in watershed.	High	Ongoing	WATERSHED COUNCIL	E	0
AP1	Low	Oil, Fuel + Contaminant Mgt.	Maintain programs for handling oil, fuel, pesticides and other potential contaminates. Respond to all accidental spills.	High	Ongoing	DEP/bpc	E	0

** Assumes current level of funding within NRCS.

Entities Abbreviations (alphabet soup)
ASA - Atlantic Salmon Authority, Maine
ASTF - Atlantic Salmon Task Force (Governor's), Maine
BPC - Board of Pesticides Control, Maine
DAFRR - Department of Agriculture, Food and Rural Resources, Maine
DEP - Department of Environmental Protection, Maine
HUG - Human User Group - landowners and local interested parties, Maine
IF&W - Inland, Fisheries and Wildlife, Maine
LURC - Land Use Regulation Commission, Maine
LWRC - Land and Water Resources Council
NRCS - Natural Resources Conservation Service, Federal
SWCD - Soil and Water Conservation District, local
UMCE - University of Maine Cooperative Extension, Maine
USFWS - United States Fish and Wildlife Service, Federal
WC - Watershed Councils

Table 2.2. Narraguagus River: Schedule for implementing actions that will reduce threat to Atlantic salmon habitat from agricultural activities and promote recovery of Atlantic salmon populations.

Watershed: NARRAGUAGUS RIVER Director of implementation: Pleasant River Watershed Steering Committee								
TASK CODE	**PRIORITY**	**ACTIVITY**	**ACTION TO REDUCE THREATS AND PROMOTE RECOVERY**	**ACTION FEASIBILITY**	**TIME PERIOD**	**RESPONSIBILITY .LEAD in CAPS .cooperators in lower case**	**RESOURCES .Existing .New .Annual**	**ESTIMATED NEW FUNDING**
WU2	Moderate	Water Use	Develop Total Water Use Management Plan. adopt total water management plan approach establish watershed council report preliminary watershed evaluation to water use working group	High	3/96-8/96 Done 5/96 11/96	NRCS/asa,dafrr, dep, hug, if&w, lurc,usfws ASTF LWRC NRCS	E	0
WU2	Moderate	Water Use	Develop best alternatives from Total Water Use Management Plan.	High	9/96-1/98	NRCS/asa,dep, dafrr,dep,hug, if&w,lurc,usfws	E $200,000** $300,000	0
WU3	Moderate	Water Use	Seek funding to implement Total Water Use Management Plan.	To be determined	98-08	LWRC	N	be deter- mined
WU5	High	Water Use	Define thermal plume associated with direct discharges.	High	97	ASA/dep	E	0
AP4	Moderate	Pesticide Use General	Enhance monitoring and regulatory activities of Board of Pesticides Control.	High	Ongoing	BPC	E	0
AP1	Moderate	Pesticide Use Target Crops	Target ICM educational programs and promote use of BMPs on blueberries and cranberries.	High	Ongoing	UMCE/bpc,swcd, nrcs	E,A $3,000	0
AP1	Moderate	Hexazinone Use	Implement Hexazinone State Management Plan for the Protection of Groundwater and monitor effectiveness of BMPs.	High	Ongoing	BPC/umce,growers	A $1,000	0
AP7	Low	Direct discharges	Continue compliance monitoring and reporting to DEP.	High	Ongoing	processors	E	0
AP5	Moderate	Hexazinone use	Determine if hexazinone exposure has sublethal or chronic effects on Atlantic salmon.	High	99	ASA/usfws	N	60,000
AP1	Low	Agricultural Practices	Implement proactive NPS and technical assistance programs to assist growers in adopting applicable practices (BMPs) and monitor effectiveness.	High	97 + 98	SWCD/nrcs,umce, dafrr	N	$20,000 /2 years

AP1	Low	Biosolids Utilization	Maintain DEP siting standards and have ASA review permit applications.	High	Ongoing	ASA/dep	E	0
AP3	Low	Wetlands Alteration	Develop inventory of high value wetlands in watershed.	High	Ongoing	WATERSHED COUNCIL	E	0
AP1	Low	Oil, Fuel + Contaminant Mgt.	Maintain programs for handling oil, fuel, pesticides and other potential contaminates. Respond to all accidental spills.	High	Ongoing	DEP/bpc	E	0
PM4 PM5	High	Peat Mining	Continue water quality and compliance monitoring.	High	Ongoing	DEP/Worcester Peat Co.	E	0
PM1	Moderate	Peat Mining	Improve permit review and required standards.	High	Ongoing	DEP/lurc	E	0
PM3	High	Peat Mining	Estimate threat from water quality changes.	High	Ongoing	IF&W/usfws, asa	E	0

** Assumes current level of funding within NRCS.

Entities Abbreviations (alphabet soup)

ASA - Atlantic Salmon Authority, Maine
ASTF - Atlantic Salmon Task Force (Governor's), Maine
BPC - Board of Pesticides Control, Maine
DAFRR - Department of Agriculture, Food and Rural Resource, Maine
DEP - Department of Environmental Protection, Maine
HUG - Human User Group - landowners and local interested parties, Maine
IF&W - Inland, Fisheries and Wildlife, Maine
LURC - Land Use Regulation Commission, Maine
LWRC - Land and Water Resources Council
NRCS - Natural Resources Conservation Service, Federal
SWCD - Soil and Water Conservation District, local
UMCE - University of Maine Cooperative Extension, Maine
USFWS - United States Fish and Wildlife Service, Federal
WC - Watershed Councils

Table 2.3. Machias River: Schedule for implementing actions that will reduce threat to Atlantic salmon habitat from agricultural activities and promote recovery of Atlantic salmon populations.

Watershed: MACHIAS RIVER Director of implementation: Pleasant River Watershed Steering Committee								
TASK CODE	**PRIORITY**	**ACTIVITY**	**ACTION TO REDUCE THREATS AND PROMOTE RECOVERY**	**ACTION FEASIBILITY**	**TIME PERIOD**	**RESPONSIBILITY .LEAD in CAPS .cooperators in lower case**	**RESOURCES .Existing .New .Annual**	**ESTIMATED NEW FUNDING**
WU2	Moderate	Water Use	Develop Total Water Use Management Plan. adopt total water management plan approach establish watershed council report preliminary watershed evaluation to watershed council	High	3/97-8/97 Done 97 97	NRCS/asa,dafrr, dep,hug,if&w, lurc,usfws ASTF LWRC NRCS	E	0
WU2	Moderate	Water Use	Develop best alternatives from Total Water Use Management Plan.	High	10/97-4/99	NRCS/asa,dep, dafrr,dep,hug, if&w,lurc,usfws	E $200,000** $300,000	0
WU3	Moderate	Water Use	Seek funds to implement Total Water Management Plan.	To be determined	99-09	LWRC	N	to be determined
WU5	High	Water Use	Define thermal plume associated with direct discharges.	High	96	ASA/dep	E	0
WU4	High	Water Use	Request USGS to reestablish gaging station.	High	97	LWRC	N	to be determined
AP4	Moderate	Pesticide Use General	Enhance monitoring and regulatory activities of Board of Pesticides Control.	High	Ongoing	BPC	E	0
AP1	Moderate	Pesticide Use Target Crops	Target ICM educational programs and promote use of BMPs on blueberries and cranberries.	High	Ongoing	UMCE/bpc,swcd, nrcs	E,A $2,000	0
AP1	Moderate	Hexazinone Use	Implement Hexazinone State Management Plan for the Protection of Groundwater and monitor effectiveness of BMPs.	High	Ongoing	BPC/umce,growers	A $1,000	0
AP1	Low	Agricultural Practices	Implement proactive NPS and technical assistance programs to assist growers in adopting applicable	High	97 + 98	SWCD/nrcs,umce,	N,A	$20,000

			practices (BMPs) and monitor effectiveness.			dafrr		/2 years
AP1	Low	Biosolids Utilization	Maintain DEP siting standards and have ASA review permit applications.	High	Ongoing	ASA/dep	E	0
AP3	Low	Wetlands Alteration	Develop inventory of high value wetlands in watershed.	High	Ongoing	WATERSHED COUNCIL	E	0
AP1	Low	Oil, Fuel + Contaminant Mgt.	Maintain programs for handling oil, fuel, pesticides and other potential contaminates. Respond to all accidental spills.	High	Ongoing	DEP/bpc	E	0
PM2	High	Peat Mining	Review application for new mine.	High	Ongoing	LURC/dep,if&w. asa	E	0

** Assumes current level of funding within NRCS.

Entities Abbreviations (alphabet soup)

ASA - Atlantic Salmon Authority, Maine
ASTF - Atlantic Salmon Task Force (Governor's), Maine
BPC - Board of Pesticides Control, Maine
DAFRR - Department of Agriculture, Food and Rural Resource, Maine
DEP - Department of Environmental Protection, Maine
HUG - Human User Group - landowners and local interested parties, Maine
IF&W - Inland, Fisheries and Wildlife, Maine
LURC - Land Use Regulation Commission, Maine
LWRC - Land and Water Resources Council
NRCS - Natural Resources Conservation Service, Federal
SWCD - Soil and Water Conservation District, local
UMCE - University of Maine Cooperative Extension, Maine
USFWS - United States Fish and Wildlife Service, Federal
WC - Watershed Councils

Table 2.4. Sheepscot River: Schedule for implementing actions that will reduce threat to Atlantic salmon habitat from agricultural activities and promote recovery of Atlantic salmon populations.

Watershed: SHEEPSCOT RIVER Director of implementation: Pleasant River Watershed Steering Committee								
TASK CODE	**PRIORITY**	**ACTIVITY**	**ACTION TO REDUCE THREATS AND PROMOTE RECOVERY**	**ACTION FEASIBILITY**	**TIME PERIOD**	**RESPONSIBILITY .LEAD in CAPS .cooperators in lower case**	**RESOURCES .Existing .New .Annual**	**ESTIMATED NEW FUNDING**
AP2	High	Conservation	Adopt watershed management approach and monitor progress.	High	Done	ASTF	E	0
AP2	High	Conservation	Establish a watershed council.	High	97	ASTF	E	0
AP2	High	NPS	Target Sheepscot River for a land use oriented, watershed-specific NPS program.	High	Ongoing	ASTF/LWRC	E	0
AP2	High	NPS	Seek funding to develop, coordinate and implement a watershed-specific NPS program.	High	Ongoing	DAFRR/steering committee, dep,spo	E	0
AP2	Moderate	NPS	Survey NPS program effectiveness with substrate embeddedness survey and Atlantic salmon population assessments.	High	96 & 97	ASA	N	to be deter-mined
AP1	High	Agricultural Practices	Implement proactive NPS and BMPs technical assistance programs to enable farmers to adopt appropriate practices and monitor effectiveness.	High	97 & 98	SWCD/nrcs,umce, dafrr	E,N	60,000/2 years
AP1	High	Biosolids Utilization	Enforce DEP siting and landspreading standard sand have ASA review permit applications.	ASA/dep	E	to be determined		
AP4	Low	Pesticide Use: General	Enhance monitoring and regulatory activities of Board of Pesticides Control.	BPC	N	?		
AP1	Low	Pesticide Use: Crops	Target ICM educational programs and promote use of BMPs for Christmas trees and corn.	UMCE/bpc, swcd, nrcs	E	0		
AP3	Moderate	Wetlands Alteration	Identify wetlands with water quality benefits to Atlantic salmon.	WATERSHED COUNCIL	E	0		
AP1	Low	Oil, Fuel + Contaminant Mgt.	Maintain programs for handling oil, fuel, pesticides and other potential contaminates. Respond to all accidental spills.	DEP/bpc	E	0		

Entities Abbreviations (alphabet soup)

ASA - Atlantic Salmon Authority, Maine
ASTF - Atlantic Salmon Task Force (Governor's), Maine
BPC - Board of Pesticides Control, Maine
DAFRR - Department of Agriculture, Food and Rural Resources, Maine
DEP - Department of Environmental Protection, Maine
HUG - Human User Group - landowners and local interested parties, Maine
IF&W - Inland, Fisheries and Wildlife, Maine
LURC - Land Use Regulation Commission, Maine
LWRC - Land and Water Resources Council
NRCS - Natural Resources Conservation Service, Federal
SPO - State Planning Office, Maine
SWCD - Soil and Water Conservation District, local
UMCE - University of Maine Cooperative Extension, Maine
USFWS - United States Fish and Wildlife Service, Federal
WC - Watershed Councils

Table 2.5. East Machias River: Schedule for implementing actions that will reduce threat to Atlantic salmon habitat from agricultural activities and promote recovery of Atlantic salmon populations.

Watershed: EAST MACHIAS RIVER Director of implementation: Pleasant River Watershed Steering Committee								
TASK CODE	**PRIORITY**	**ACTIVITY**	**ACTION TO REDUCE THREATS AND PROMOTE RECOVERY**	**ACTION FEASIBILITY**	**TIME PERIOD**	**RESPONSIBILITY .LEAD in CAPS .cooperators in lower case**	**RESOURCES .Existing .New .Annual**	**ESTIMATED NEW FUNDING**
AP2 WU2	High	Conservation	Adopt watershed management approach and monitor progress.	High	Done	ASTF	E	0
	High	Conservation	Review need for watershed councils to address these needs.	High	Annual	LWRC	E	0
AP4	Moderate	Pesticide Use General	Enhance monitoring and regulatory activities of Board of Pesticides Control.	High	Ongoing	BPC	E	0
AP1	Moderate	Pesticide Use Target Crops	Target ICM educational programs and promote use of BMPs on blueberries and cranberries.	High	Ongoing	UMCE/bpc,swcd, nrcs	E,A $1,000	0
AP1	Moderate	Hexazinone Use	Implement Hexazinone State Management Plan for the Protection of Groundwater and monitor effectiveness of BMPs.	High	Ongoing	BPC/umce,growers	A $4,000	0
AP1	Low	Agricultural Practices	Implement proactive NPS and technical assistance programs to assist growers in adopting applicable practices (BMPs) and monitor effectiveness.	High	97 + 98	SWCD/nrcs,umce, dafrr	E	0
AP1	Low	Biosolids Utilization	Maintain DEP siting standards and have ASA review permit applications.	High	Ongoing	ASA/dep	E	0
AP3	Low	Wetlands Alteration	Develop inventory of high value wetlands in watershed.	High	Ongoing	WATERSHED COUNCIL	E	0
AP1	Low	Oil, Fuel + Contaminant Mgt.	Maintain programs for handling oil, fuel, pesticides and other potential contaminates. Respond to all accidental spills.	High	Ongoing	DEP/bpc	E	0

Entities Abbreviations (alphabet soup)

ASA - Atlantic Salmon Authority, Maine
ASTF - Atlantic Salmon Task Force (Governor's), Maine
BPC - Board of Pesticides Control, Maine
DAFRR - Department of Agriculture, Food and Rural Resources, Maine

DEP - Department of Environmental Protection, Maine
HUG - Human User Group - landowners and local interested parties, Maine
IF&W - Inland, Fisheries and Wildlife, Maine
LURC - Land Use Regulation Commission, Maine
LWRC - Land and Water Resources Council
NRCS - Natural Resources Conservation Service, Federal
SWCD - Soil and Water Conservation District, local
UMCE - University of Maine Cooperative Extension, Maine
USFWS - United States Fish and Wildlife Service, Federal
WC - Watershed Councils

Table 2.6. Dennys River: Schedule for implementing actions that will reduce threat to Atlantic salmon habitat from agricultural activities and promote recovery of Atlantic salmon populations.

Watershed: DENNYS RIVER Director of implementation: Pleasant River Watershed Steering Committee								
TASK CODE	**PRIORITY**	**ACTIVITY**	**ACTION TO REDUCE THREATS AND PROMOTE RECOVERY**	**ACTION FEASIBILITY**	**TIME PERIOD**	**RESPONSIBILITY .LEAD in CAPS .cooperators in lower case**	**RESOURCES .Existing .New .Annual**	**ESTIMATED NEW FUNDING**
AP2 WU2	High	Conservation	Adopt watershed management approach and monitor progress.	High	Done	ASTF	E	0
	High	Conservation	Review need for watershed councils to address these issues.	High	Annual	LWRC	E	0
AP4	Moderate	Pesticide Use General	Enhance monitoring and regulatory activities of Board of Pesticides Control.	High	Ongoing	BPC	E	0
AP1	Moderate	Pesticide Use Target Crops	Target ICM educational programs and promote use of BMPs on blueberries and cranberries.	High	Ongoing	UMCE/bpc,swcd, nrcs	E,A $1,000	0
AP1	Moderate	Hexazinone Use	Implement Hexazinone State Management Plan for the Protection of Groundwater and monitor effectiveness of BMPs.	High	Ongoing	BPC/umce,growers	A $4,000	0
AP1	Low	Agricultural Practices	Implement proactive NPS and technical assistance programs to assist growers in adopting applicable practices (BMPs) and monitor effectiveness.	High	97 + 98	SWCD/nrcs,umce, dafrr	E	0
AP1	Low	Biosolids Utilization	Maintain DEP siting standards and have ASA review permit applications	High	Ongoing	ASA/dep	E	0
AP3	Low	Wetlands Alteration	Develop inventory of high value wetlands in watershed.	High	Ongoing	WATERSHED COUNCIL	E	0
AP1	Low	Oil, Fuel + Contaminant Mgt.	Maintain programs for handling oil, fuel, pesticides and other potential contaminates. Respond to all accidental spills.	High	Ongoing	DEP/bpc	E	0

Entities Abbreviations (alphabet soup)

ASA - Atlantic Salmon Authority, Maine
ASTF - Atlantic Salmon Task Force (Governor's), Maine
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DAFRR - Department of Agriculture, Food and Rural Resources, Maine
DEP - Department of Environmental Protection, Maine
HUG - Human User Group - landowners and local interested parties, Maine
IF&W - Inland, Fisheries and Wildlife, Maine
LURC - Land Use Regulation Commission, Maine
LWRC - Land and Water Resources Council
NRCS - Natural Resources Conservation Service, Federal
SWCD - Soil and Water Conservation District, local

UMCE - University of Maine Cooperative Extension, Maine
USFWS - United States Fish and Wildlife Service, Federal
WC - Watershed Councils

Table 2.7. Ducktrap River: Schedule for implementing actions that will reduce threat to Atlantic salmon habitat from agricultural activities and promote recovery of Atlantic salmon populations.

Watershed: DUCKTRAP RIVER Director of implementation: Pleasant River Watershed Steering Committee								
TASK CODE	**PRIORITY**	**ACTIVITY**	**ACTION TO REDUCE THREATS AND PROMOTE RECOVERY**	**ACTION FEASIBILITY**	**TIME PERIOD**	**RESPONSIBILITY .LEAD in CAPS .cooperators in lower case**	**RESOURCES .Existing .New .Annual**	**ESTIMATED NEW FUNDING**
AP2 WU2	High	Conservation	Adopt watershed management approach and monitor progress.	High	Done	ASTF	E	0
	High	Conservation	Review need for watershed councils to address these issues.	High	Annual	LWRC	E	0
AP4	Low	Pesticide Use General	Enhance monitoring and regulatory activities of the Board of Pesticides Control.	High	Ongoing	BPC	E	0
AP3	Low	Wetlands Alteration	Continue education and compliance with current wetlands regulations.	High	Ongoing	DEP	E	0
AP1	Low	Oil, Fuel + Contaminant Mgt.	Maintain programs for handling oil, fuel, pesticides and other potential contaminates. Respond to all accidental spills.	High	Ongoing	DEP/bpc	E	0

Entities Abbreviations

ASA - Atlantic Salmon Authority, Maine
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DEP - Department of Environmental Protection, Maine
HUG - Human User Group - landowners and local interested parties, Maine
IF&W - Inland, Fisheries and Wildlife, Maine
LURC - Land Use Regulation Commission, Maine
LWRC - Land & Water Resources Council
NRCS - Natural Resources Conservation Service, Federal
SWCD - Soil and Water Conservation District, local
UMCE - University of Maine Cooperative Extension, Maine
USFWS - United States Fish and Wildlife Service, Federal

H. Aquaculture

Potential Impacts to Maine River Specific
Atlantic Salmon Populations from Aquaculture-Reared Salmon

Introduction:

Since the mid 1980s, sea-run Atlantic salmon returns to the seven Maine downeast rivers (Dennys, East Machias, Machias, Narraguagus, Pleasant, Ducktrap and Sheepscot) have exhibited a declining trend. Although the precise reasons for this decline have not been identified, reduced sea survival appears to be the major factor. Since public and private Atlantic salmon culture operations are located on or adjacent to six of the seven (Ducktrap River excluded) downeast rivers, the State of Maine proposes to carry out programs to minimize any potential adverse impacts on wild sea-run Atlantic salmon. The following report identifies potential impacts and strategies to protect wild Atlantic salmon from publicly and privately cultured salmon.

Overview of Issues from an Aquaculture Perspective:

This report summarizes the findings of the Aquaculture Working Group of Maine's Atlantic Salmon Task Force regarding Atlantic salmon aquaculture in the vicinity of the seven rivers proposed for listing, the potential for interactions between domesticated and wild salmon popula-tions, and other potential adverse impacts on wild Atlantic salmon associated with Atlantic salmon aquaculture activities. Impacts could occur in marine or riverine environments. Potential impacts in the marine environment are limited to the risk of disease and parasite transfer between populations. Potential impacts in freshwater environments include direct competition between wild and escaped domesticated populations for food, habitat and reproductive opportunity, as well as the risk of disease transfer. The Maine Department of Marine Resources (P.L. 1991, c. 381) is the lead state agency responsible for permitting and monitoring of aquaculture in Maine's coastal waters.

All of the issues related to salmon aquaculture in Maine have an international dimension. More than 60 percent of Maine Atlantic salmon production straddles the Maine/New Brunswick border and more than 90 percent occurs within 30 miles of that border. Maine growers annually stock 3 to 3.5 million smolts in sea cages in eastern Maine, all raised on entirely different watersheds than those near which they are stocked, and accounting for only one-third of the total number of Atlantic salmon annually stocked in sea cages in the immediate vicinity of the five eastern Maine wild salmon rivers. New Brunswick growers stock an additional 6 to 7 million St. John strain smolts annually in the internationally shared waters of Passamaquoddy Bay, limiting the effective-ness of wild protection strategies that rely on the marking or containment of farmed fish in the absence of an international agreement. Protection strategies applied to U.S. fish will not be applied to fish reared in Canada.

The report presents an overview of aquaculture activities in the State of Maine with special emphasis on activities that occur in the vicinity of the seven identified wild rivers, followed by an outline form discussion of potential impacts to wild salmon from: (1) Interbreeding, (2) Redd Superimposition, (3) Direct Competition and (4) Disease. Potential impacts on wild salmon populations from interaction with farmed salmon are listed in Table 1, together with the specific wild salmon rivers potentially affected by each activity, recommended actions to reduce risk and promote recovery, potential and feasibility of reducing interactions, lead agency, implementation dates, estimated costs of recommended actions, discussion/rationale for recommended actions and alternatives considered but not selected. Table 2 lists potential risks to wild salmon related to fish culture operations, ongoing actions to minimize threats and alternatives to ongoing activities.

Overview of Atlantic Salmon Aquaculture in Maine:

Salmon aquaculture in Maine's coastal waters began in the early 1970s in the mid-coast region, where Pacific coast coho salmon were cultured to pan-size fish and marketed in the Northeast restaurant trade. These early ventures were unsuccessful due to adverse environmental conditions at grow-out sites, low market value of the product and lack of infrastructure to support the fledgling industry. By the early 1980s, successful experimental culture of Atlantic salmon in New Brunswick was followed by rapid growth of private commercial aquaculture ventures on both sides of the border. By 1987, several family-run farms, local venture capital firms and international aquaculture corporations were investing in and developing operations in the region. These operations were highly successful due to good water quality; warm, nonlethal winter water temperatures in the Passamaquoddy Bay area; favorable market prices; and the proximity to Canadian operations, which provided critical infrastructure support including feed, sea cage technology, veterinary services and husbandry expertise.

The current Maine industry is comprised of nine companies, down from 18 in 1989, which operate 25 sea cage sites on 840 acres of leased water, six freshwater smolt-rearing facilities on four rivers and five fish processing plants. Annual harvests in the state now exceeds 10,000 metric tons valued at $55 million, representing slightly more than 2.5 percent of the total farmed salmon production in the North Atlantic region to which the species is indigenous. Industry expansion has slowed significantly from the triple digit rates of the 1987-1991 period and depends more heavily on improvements in average fish size than on increasing smolt placement for grow-out. Only eight new lease sites have been developed during the 1990s, down from 18 new sites in 1989 alone. While site development has remained moderate, cage numbers, sizes and quality have undergone a more considerable change. Bettencourt and Anderson (1990) identified 355 sea cages in operation in Maine in their comprehensive 1989 survey of the industry for USDA's Northeastern Regional Aquaculture Center. A 1995/96 survey for FDA therapeutant trials by University of Maine veterinarian, H. Michael Opitz, identified 772 cages in place, an average increase of 16 percent per year. The most dramatic change evidenced between the two surveys is a shift to the use of modern, large diameter, HDPE circle cages of Norwegian manufacture, which increased from 12 to 149. Another 24 small diameter HDPE circles were also deployed in this period, up from 0 in 1989. The cage of choice remains 12 and 15 meter steel net pens manufactured in New Bruns-wick, which increased from 284 to 546 between the surveys. A small remnant of the industry's earliest days remains in approximately 10 site-built, 10 meter wooden cages still in service, down from 36 in 1989. Site intensity has increased through the period, from an average 21 cages per site to 30. The majority of farms deployed between four and 12 cages per site in 1989; the majority deploy between nine and 40 today. Compared with the projections developed for 1995 in the Bettencourt and Anderson survey, only 44 percent of a projected 59 farm sites are in production and harvests have reached only 80 percent of the 12,000 metric tons anticipated in 1990. Annual smolt placements of 3 to 3.5 million fish are held for approximately 18 months, yielding an average standing crop of about 4.7 million fish in two year classes. The principal strains under production are Penobscot and St. John, which are reared in about equal proportions, while the Norwegian Landcatch strain represents the remaining 10% of the total production. The Penobscot strain was developed from eggs and smolt originally made available by the Maine Atlantic Salmon Commission and U.S. Fish & Wildlife Service. The St. John strain was originally provided by the Canadian Department of Fisheries & Oceans from the Moctaquac and St. John hatcheries in New Brunswick. The Landcatch strain originated from eggs imported prior to the 1989 State of Maine prohibition of such importations. Early experimentation with other strains has been abandoned. The majority of aquaculture rearing of Atlantic salmon in the near shore marine environment occurs in proximity to the five eastern Maine wild salmon rivers, including the Dennys, East Machias, Machias, Narraguagus and Pleasant. There are no sea cage rearing sites in the vicinity of the Sheepscot or Ducktrap Rivers. Of the 16 freshwater salmonid hatcheries in the State of Maine, only three are located on wild salmon rivers. The State of Maine operates a hatchery near the headwaters of the Sheepscot River and Connors Aquaculture, Inc. operates one hatchery each on the lower portions of the East Machias and Pleasant watersheds.

THREATS TO WILD ATLANTIC SALMON RECOVERY:

I. Potential Impacts to Wild Salmon and Habitat

Potential impacts to wild salmon associated with Atlantic salmon aquaculture could result from interactions between farmed and wild populations which could reduce wild salmon productivity or increase incidence of disease. There is no directed trapping, capturing, or killing of wild salmon associated with commercial aquaculture activities. There is no physical alteration of wild salmon habitat associated with public or commercial aquaculture.

I-1. Rearing of salmonids at sea cage and hatchery concentrations greater than found in nature may increase the potential for a clinical outbreak of disease or parasite infestation associated with pathogens endemic to Maine waters. A clinical outbreak of disease or infestation in a highly concentrated population could exacerbate the effects of the existing reservoir of endemic pathogens available for transmission to wild populations. Movement or transfer of fish into the state and from one geographic region to another within the state could result in the introduction of exotic pathogens to state waters which could be transmitted to wild populations. Disease threats to wild recovery arising from aquaculture activities involve the freshwater environments of the Sheepscot, East Machias and Pleasant watersheds, where salmonid hatcheries are located; the coastal waters adjacent to the Dennys, East Machias, Machias, Narraguagus and Pleasant Rivers, where salmon grow-out sites are located; and the freshwater environments of all seven wild rivers where state and federal government salmonid stocking programs are conducted or where farmed escapees may stray. Commercial hatcheries on the East Machias and Pleasant watersheds are third-party inspected and certified disease-free facilities, which meet Canadian, U.S. and State of Maine fish health requirements. The public hatchery on the Sheepscot watershed, operated by the State of Maine Department of Inland Fish & Wildlife, is evaluated by the Department's fish pathologist.

Disease control in the State's wild salmonid populations has been a priority for the Maine Department of Inland Fish & Wildlife for the past 40 years, resulting in a fish health regulatory structure that is among the most stringent in the nation. Maine also complies with the New England Fish Health Guidelines within the State's jurisdiction and has agreed to convene a joint federal/state/industry Fish Health Advisory Board to make additional expertise available to the Commissioners of Marine Resources and of Inland Fish & Wildlife. Disease risk to wild salmon is limited by ongoing enforcement of Maine's stringent fish health standards, by state control over the movement of salmonids into and around the state from either public or private culture facilities and by the continued aggressive monitoring of fish health conditions in culture facilities and in the wild. Disease risk to wild salmon will be further limited by the development of an emergency disease eradication program to identify, through public and private sector consultations, action steps to be taken in the event of the discovery of emergency (exotic) fish pathogens in public or private rearing facilities and by the expansion of an ongoing epidemiological monitoring program to determine the type, incidence and geographic distribution of salmonid pathogens in Maine. Disease risk from commercial aquaculture is currently minimized as a result of husbandry practices at hatcheries and cage sites that emphasize the placement of disease-free fish (certification, vaccination, pair mating, 100 percent lethal testing) in sea cages and that monitor and respond to fish health conditions throughout the grow-out period (retrieval of mortalities, feeding behavior observation, veterinary intervention, disease and parasite treatment). Industry husbandry practices will be documented and evaluated and the most effective compiled in a code of practice by the University of Maine cooperating with the Maine Aquaculture Association. Current restrictions in statute and rule are considered adequate to safeguard wild salmon from diseases that might be transmitted via aquaculture fish.

I-2. Potential environmental impacts associated with farmed salmon escapees include genetic interchange with wild populations, superimposition of redds over those of wild salmon and direct competition between river-specific and farmed fish offspring for food and habitat. The risk of potential impacts of reproductive competition between cultured strays and wild stocks may be increased on the East Machias and Pleasant River watersheds, where both marine sea cages and freshwater hatcheries are located. Farmed salmon escapees on these watersheds could originate from either early juvenile escapes into rivers or from late juvenile escapes from sea cages. Mature fish are not held in Maine waters, except for river-specific and commercial broodstocks.

Salmon originating from farming operations have been observed in eight Maine rivers to date, three of which -- the Dennys, East Machias and Narraguagus -- support wild salmon populations. Although not documented on the Machias River, the Maine Atlantic Salmon Authority believes that aquaculture escapees may occur with the same frequency as has been observed on the Dennys and East Machias Rivers. The first documented incidence of farmed salmon in Maine rivers occurred in 1990, when a minimum of 17 percent (14 of 83 fish) of the rod catch in the East Machias River was of farmed origin. There were few reports of farm origin salmon in Maine rivers in 1991 and 1992. In 1993, there were an estimated 20 aquaculture strays in the Dennys River, which had a documented run of 40-50 salmon. In 1994, of a total Dennys River weir catch of 47 salmon, all but five were of farmed origin; one aquaculture stray was observed in the Narraguagus River. Preliminary trap catch results for 1995 identified four farm escapees in a total of nine salmon on the Dennys River. Farmed origin salmon were also apparently caught (and released) by anglers fishing the Dennys and East Machias Rivers in 1995.

Potential escape of juvenile salmon from sea cages adjoining the five eastern Maine wild salmon rivers is concentrated in the winter months when threats to equipment integrity from storm damage and seal attacks are most significant. Post-smolts nearing the completion of the first sea winter are the preponderant age class present on sea cage sites during this period of greatest risk, which maximizes the exposure of marine strays to mortality risk in the wild prior to maturation. While immature escapees have been documented in wild salmon rivers, full maturation must be achieved before any risk to wild salmon of genetic interchange or redd superimposition can occur. In 1996, mature escapees were documented in Maine rivers. Where escapees do survive to maturity, some European evidence suggests they would spawn later in the year (Lura and Saegrov, 1991; Jonsson et al, 1991) and lower in the rivers than do wild stocks (Webb et al, 1991). Late spawning would help limit the opportunity for direct genetic interchange with wild salmon stocks, while downriver spawning would help limit the opportunity for disruption of wild salmon redds.

Escape control efforts by salmon growers are directed at minimizing the impact of storms through careful site selection, regular equipment maintenance and storm preparation procedures that include gear inspections and relocation of drift-prone equipment. Seal-induced escapes are controlled by efforts to reduce seal access to primary containment nets on sea cages through the use of double bottoms, predator curtains and acoustic deterrent devices. Additional reductions of seal-induced escapement toward an achievable minimum, however, may require the reauthoriza-tion of limited lethal take through federal action. Prior to implementation of lethal take programs, studies will be undertaken to determine the efficacy of lethal take as a loss control strategy. Industry loss control practices will be evaluated and the most effective compiled in a code of practice by University of Maine bioresource engineers cooperating with the Maine Aquaculture Association.

II. Aquaculture Activities with Potential to Impact Wild Salmon

There are six key steps (Figure 1) involved in commercial Atlantic salmon aquaculture where risk of interaction with wild populations may occur: (1) transfer or importation of Atlantic salmon eggs into freshwater fish culture facilities; (2) freshwater culture of eggs to the smolt stage; (3) smolt transfers to sea cages; (4) grow-out of juveniles in sea cages into the second sea winter; (5) harvest of production fish for commercial market; and (6) retention of broodstock for spawning and egg take for application to Step #1. A variation of this production cycle also characterizes public sector Atlantic salmon aquaculture for fisheries management in which Step #2 is typically completed only through the fry stage, Step #3 is a transfer of juveniles to public waters, and Steps #4 and 5 are eliminated. Table 2 identifies the potential impacts to wild salmon related to these steps, severity of impact, specific salmon rivers affected, recommended actions to reduce identi-fied threats and promote recovery, potential to reduce impact, feasibility of accomplishing activity, lead agency, implementation schedule, estimated cost, rationale behind ongoing activity, and alternative to ongoing activity.

II-1. Importation of Atlantic salmon eggs into Maine, egg take from Atlantic salmon exposed to open water conditions and movement of eggs from place to place within the state could result in the introduction of exotic pathogens to state waters or the expansion of endemic pathogens to previously unaffected areas of the state. The risk of exotic pathogen introduction is currently minimized under P.L. 1995, c. 406, '4 & 5, which prohibits importation of salmonids from Icelandic or European waters and from North America west of the Continental Divide. Permitted egg transfers and importations are subject to stringent state fish health regulations, which include egg disinfection both before and after transfer. There are federal regulations that cover importa-tion of live fish or eggs into the U.S. Current Maine fish health requirements meet or exceed the New England Salmonid Health Guidelines, NASCO guidelines and Title 50 federal requirements. Besides exceeding general and regional requirements, most commercial hatcheries perform 100 percent lethal sampling of broodstock and observe pair mating protocols to track the fish health background of progeny. Two hatcheries maintain physically separated hatching and rearing stations to further reduce the risk of disease transmission. Eggs taken by state and federal wildlife managers from fish exposed to open water conditions are disinfected and subject to internal departmental protocols.

II-2. Escape of salmonid juveniles from freshwater hatcheries in the Sheepscot, East Machias, and Pleasant watersheds could result in hatchery stocks competing with juvenile wild salmon in the riverine environment for food and habitat and could transmit pathogens acquired subsequent to escape. In order to address this problem, the aquaculture industry will establish a code of practices for freshwater culture facilities to minimize escapes of juveniles and follow existing and recommended fish health protocols as discussed above at I-1. Escaped Atlantic salmon juveniles which survive in the riverine environment could interbreed with returning wild spawners as precocious parr or could migrate with wild smolt and return to the rivers at maturity to spawn with wild salmon stocks. Returns of hatchery smolts associated with intentional stocking activities and involving stocks believed to be better adapted to survival in the wild than are domesticated salmon occur at a rate of two to five per thousand, establishing an effective ceiling on the rate of returning spawners of farm origin.

Potential escape of juvenile salmon from hatcheries on the Pleasant and East Machias River watersheds is restricted to a narrow window when alevins are small enough to pass through drain screens in salmon start-feed tanks. Fry escapement is believed to be minimal, but biomass measurement techniques used by hatcheries are not sufficiently sensitive to track individual fish. Screen mesh size of about 1/32 inch limits the escape window to a period of several weeks, during which newly hatched fry attempt to remain motionless and hidden while absorbing their yolk sacs. Fry which pass through the drain screens are deposited in shallow settling basins required for treatment of commercial hatchery wastewater where mortality is extremely high due to the low oxygen availability and extreme temperatures characteristic of the basin environment. Additional screening can be located at settling basin outfalls. Screens, drains and containment systems are routinely dismantled, inspected, cleaned and reassembled at the end of each year class production cycle.Hatchery loss control measures will be included in the Loss Control Code of Practices to minimize the possibility of escapes.

II-3. Juvenile salmon are raised to smolt stage in freshwater at commercial rearing stations for 12 months (known as S-0) to 18 months (known as S-1), vaccinated against the principal diseases endemic to Maine waters (furunculosis and two forms of vibrio) and the S-1s placed in sea cages during the period April through June. The S-0s, which occur in much smaller numbers, are stocked in sea cages in October. These newly vaccinated and certified disease-free fish pose no threat of disease transmission to wild stocks prior to exposure to the existing reservoir of endemic pathogens in Maine waters. Newly stocked smolts could escape during transfer to sea cages or from containment nets after placement. Potential impact on wild populations is restricted to the extent that escaped farm-origin smolts which survive in the marine environment to maturity and return to the wild salmon rivers compete for reproductive opportunities with wild populations. Escaped smolts do migrate to sea like their wild counterparts, but survive in the marine environ-ment at only half the rate of wild smolts (Jonsson; Jonsson and Hansen, 1991), as well as at a lower rate than do larger, older fish (Saunders, 1991).

One incident of smolt loss during transfer in Maine waters occurred prior to 1990, using hand transfer technology that has since been replaced by automated pumping techniques. High levels of human surveillance and transfer scheduling around favorable weather and sea conditions provide additional reduction of escape risk during transfer operations. Risk of post-transfer escapement from sea cages is subject to escape control efforts directed at minimizing the impact of storms through careful site selection, regular equipment maintenance and storm preparation procedures that include gear inspections and relocation of drift-prone equipment. Smolts and post-smolts through the first sea winter are rarely targeted by marauding seals and less subject to seal-induced escapement than are older fish. Transfer procedures will be included in the loss control code of practice to be developed by industry and university investigators.

II-4. About 60 percent of commercial salmon production occurs at sites on Cobscook Bay, between five and 12 miles from the Dennys River; 35 percent on Machias Bay and the estuary of the Little River, between five and seven miles from the Machias and East Machias Rivers; and the remainder occurring on Eastern and Pleasant Bays, between three and nine miles from the Pleasant River and between four and 12 miles from the Narraguagus River, and on or adjacent to Blue Hill Bay, more than 12.5 miles from a wild salmon river. Grow-out occurs throughout the year in two year classes; small numbers of a third year class are occasionally present for several spring and summer months following smolt transfers. Harvest begins 18 months after smolt placement and continues for six to nine months until a year class is completely harvested.

Winter sea conditions and seasonal attacks by seals could breach containment nets or dislocate sea cages, releasing farm origin fish at various life stages into the marine environment. Escape risk is concentrated in the period from December to April, when about 85 percent of losses occur (Mitchell, McConnell, Daniels, 1994). Atlantic salmon released in winter have been found to home poorly and do not successfully return to the location where seaward migration began (Hansen & Johnson, 1991). Two year classes of fish are on-site during the period: post-smolts placed during the previous spring and autumn remain constant at the annual stocking level; market fish are harvested steadily from October, with about half removed prior to the onset of winter and diminished numbers on site through the remainder of the season. Escape control efforts are directed at minimizing the impact of storms through careful site selection, regular equipment maintenance, storm preparation procedures that include gear inspections and relocation of drift-prone equipment and post-storm inspection of nets and rigging for weakness, damage or dislocation. Necessary repairs are made on discovery. Seal-induced escapes are controlled by efforts to reduce seal access to primary containment nets on sea cages through the use of double bottoms, predator curtains and acoustic deterrent devices. Industry loss control practices will be evaluated and the most effective compiled in a code of practice by University of Maine bio-resource engineers cooperating with the Maine Aquaculture Association.

Diseases and parasites acquired by salmon in sea cages during the grow-out period could exacer-bate the impact of an existing reservoir of endemic pathogens and parasites on wild stocks. Disease risk from commercial aquaculture is currently minimized by husbandry practices that emphasize the placement of certified disease-free fish in sea cages and that monitor and respond to fish health conditions throughout the grow-out period (retrieval of mortalities, feeding behavior observation, stress reduction, veterinary intervention, disease and parasite treatment). Industry husbandry practices will be documented and evaluated and the most effective compiled in a code of practice by the University of Maine in cooperation with the Maine Aquaculture Association.

II-5. Fish transferred from containment nets to transport vessels during weekly or biweekly harvest operations could escape into the marine environment. Intensive harvests occur from October through March; incidental harvests occur through the remainder of the year on some farms. Both live harvest and immediate slaughter techniques are employed using dip nets, braille seines and hydraulic pumps. Live fish are transferred to sealed containers for shore side slaughter; sea-killed fish are treated immediately with CO_2 to minimize activity. Harvests are scheduled around weather and sea conditions that limit risk to crews and fish. Transfer vessels range from barges to well boats, often custom designed for aquaculture operations. Harvest equipment and techniques will be included in the loss control code of practice to be developed by industry and university investigators.

II-6. Commercial broodstock, at or approaching full sexual maturity, could escape from sea cages in Cobscook and Machias Bays and enter the Dennys, Machias and East Machias Rivers where they would pose a high risk of interbreeding with wild stocks. Only three farms, fully integrated with hatchery operations, hold broodstock in Maine waters. Initial grading for broodstock occurs after the first sea winter when fish with appropriate attributes are selected and segregated from other production fish. A second round of grading occurs after the second sea winter, with culls diverted to the normal harvest. About two-thirds of the 2sw fish begin to mature through the following summer when the males and females are separated and the fish manually spawned at the sea site when full maturation occurs in November (Penobscot and St. john) and December (Landcatch). Late maturing fish are held through the third sea winter and spawned the following year. After egg and milt take, most spawners are subject to 100 percent lethal sampling for disease monitoring and prevention. Because commercial broodstock are spawned only once, 2sw spawners differ from production fish only in being held for several months beyond the normal harvest. Late maturing 3sw spawners are held through the higher risk winter months at the center of a cage grouping where storm and predator risk is minimized.

Overview of Working Group Reports:

On October 20, 1995, the Atlantic Salmon Working Group was charged with providing technical support to the Maine Atlantic Salmon Task Force, which was created by Executive Order to oversee the development of the State's response to the proposed ESA listing and the creation of a plan to conserve and restore wild salmon stocks. During a period of approximately 11 months, from May 1995 to April 1996, representatives of state and federal agencies and the commercial aquaculture industry, who comprised the Working Group, reviewed the status, economic and biological conditions, husbandry practices and technological base of public and commercial aqua-culture in Maine. Eight subcommittees undertook specific research tasks and reported their results to the Working Group, where consensus recommendations and priorities were developed. Research objectives included: (a) evaluation of interaction potentials and the risks to wild salmon associated with those interactions, (b) control options for interactions likely to result in reduced wild salmon productivity, and (c) reduction of the impact of any interactions likely to occur. The full reports of the eight subcommittees are included in Appendix I.

Subcommittee recommendations in Group (a) include continued research into an efficient, cost effective means of marking fish during vaccination. Recommendations in Group (b) include development of aquaculture industry codes of practice covering fish health and loss control, continued research into the development of a commercially viable sterile stock, endorsement of the Gulf of Maine Aquaculture-Pinniped Task Force recommendations, study effectiveness of limited lethal seal take and the installation of permanent weirs on wild salmon rivers. Recom-mendations in Group (c) include increasing the number of river-specific salmon in place in the wild salmon rivers in order to dilute the potential genetic effect of individual cross-breeding incidents and aid the recovery process by releasing fully mature, sea-cage reared salmon grown from river-specific eggs.

The Working Group found that interactions related to wild salmon productivity, habitat competition and interbreeding are limited to the freshwater environments of wild salmon rivers, while potential interactions in the marine environment are limited to the transmission of disease and parasites. The Working Group found that Canadian salmon aquaculture operations with approximately twice the Maine production volume share a common marine environment with the Maine industry, limiting the effectiveness of aquaculture exclusion zones, marking or containment technology as exclusive risk management options. The Working Group found that the impact of genetic interactions between farmed and wild stocks could be reduced by increasing the river-specific spawning population and excluding farmed salmon escapees to levels sufficient to lower the statistical significance of any individual incident involving farmed salmon escapees.

Working Group Recommendations:

1) Install permanent seasonal weirs on the Dennys, Machias, East Machias, and Pleasant Rivers in order to most efficiently prevent farm strays from entering wild salmon rivers. Continue to utilize the existing dam on the Narraguagus River to exclude farmed salmon from interacting with wild salmon.

2) Research and develop an efficient, cost effective and market-acceptable mechanism to mark farmed fish as smolts at some stage of the existing production process.

3) Pursue a program of accelerated restoration of wild stocks through river-specific stocking programs that release smolts and/or introduce the maximum genetically defensible number of cage-reared, river-specific adults onto the spawning grounds. An accelerated increase in the river-specific population base may serve to offset the current high level of marine mortality identified by the Services as fundamental to declining wild Atlantic salmon populations in the U.S.

4) Develop industry codes of practice to ensure the use of the most effective health management and loss control techniques to minimize the potential for adverse impacts.

5) Pursue an aggressive program of research into seal behavior around sea cages and into site and cage vulnerability to seal attack. Seek reauthorization of limited lethal take of seals on farm sites if studies indicate that lethal take is an effective loss control measure.

6) Continue to monitor world research into the biology and commercialization of triploid salmon.

7) Continue Maine's stringent regulation of fish health, subject to incremental improvement through the existing state/federal/industry advisory process.

River-Specific Stock Rehabilitation:

The numbers of returning adult salmon in the seven Maine rivers (Sheepscot, Ducktrap, Pleasant, Narraguagus, Machias, East Machias and Dennys) are so low that intervention is necessary to recover the stocks to sustainable levels. A cooperative program between state and federal fishery agencies and the aquaculture industry is essential to carry out river-specific stock rehabilitation programs on the wild salmon rivers. Major components of the program include the following:

1) Develop a cooperative agreement that clearly outlines responsibilities and duties of all parties involved;

2) Seek input from the genetics group to ensure that river-specific stocking programs are designed to introduce the maximum genetically defensible number of cage-reared adults onto the spawning grounds;

3) Utilize existing stocks (initially Dennys, Machias, and Narraguagus), collect stocks from selected rivers and/or stocks currently held in federal facilities (adults/parr/fry);

4) Rear stocks to smolts in participating government and private hatcheries;

5) Complete smoltification process in hatcheries and/or temporary holding sites on the river of the stock origin for stock imprinting purposes;

6) Transfer smolt to marine cages in estuaries near the home river;

7) Grow smolt to adult (16-32 months) for release to augment natural spawning; and

8) Establish milestones and targets to measure success and ensure program does not become self-perpetuating.

Marking/Tagging Weirs:

Salmon entering downeast rivers could come from several sources (river origin, aquaculture escapees, intentional releases of pen-reared river-specific salmon, or strays from salmon restoration rivers such as the Penobscot, St. Croix or Canadian rivers). A major strategy of the Aquaculture Working Group is to minimize impacts of aquaculture origin fish on wild populations by restricting their entry into wild salmon rivers. The development of weirs is a high priority strategy to reduce the possibility of cultured and wild salmon interactions. The ability to determine the origin of salmon entering a wild salmon river by readily detectable marks would enhance the effectiveness of minimizing interactions. The mark should be easy and economical to apply and detect and not adversely affect survival or marketability of farmed fish. The ability to differentiate between river-origin and pen-reared fish observed in a river, angled, or on the spawning ground would allow wild salmon managers to: 1) separate fish entering a river according to origin, thus controlling the numbers and destination of the various stocks (e.g., river-specific stocks could be released above the weirs for natural spawning or taken to hatcheries for broodstock and farmed salmon escapees would be collected and disposed of in accordance with the directives of the Maine Atlantic Salmon Authority); 2) regulate the sport fishery; 3) evaluate the success of stocking pen-reared river-specific adults; 4) determine the proportion of naturally produced fish in the run; and 5) evaluate other parameters such as straying rates, fallback from trucked adults, time/location of spawning etc.

Permitting, Monitoring & Enforcement of Aquaculture Activities:

There are a number of state laws which regulate finfish aquaculture in Maine, as follows:

* **Importation of Live Marine Organisms (12 M.R.S.A., '6071)**. It is unlawful to introduce or import for introduction into any coastal waters any live marine organisms (including Atlantic salmon) or possess such organisms without a permit issued by the Commissioner of Marine Resources. The Commissioner may only grant permits to possess, import, and introduce an organism if those actions will not endanger the indigenous marine life or its environment. This law is designed to prevent the introduction of bacteria, fungus, virus or any other infectious or contagious disease or parasite, predator or other organisms that may be dangerous to indigenous marine life or its environment.

*** Research and Aquaculture Leases (12 M.R.S.A., '6072).** This law, and subsequent revisions, authorizes the Commissioner of Marine Resources to lease areas in, on and under the coastal waters including the public lands beneath those waters and portions of the intertidal zone for scientific research or for aquaculture of marine organisms. Leases are subject to the following limitations: the maximum term is 10 years, each tract cannot exceed five acres, contiguous leases may not exceed 100 acres, and no person may have aggregate leases exceeding 200 acres. Prior to granting a lease, the Department is required to conduct an assessment of the site and adjacent area to determine potential impacts on commercially and ecologically significant flora and fauna and conflicts with traditional fisheries. Following a mandatory judicatory public hearing, the Commissioner may grant a lease provided:

A. It will not unreasonably interfere with the ingress and egress of riparian owners

B. It will not unreasonably interfere with navigation

C. It will not unreasonably interfere with fishing or other uses of the area after considering the number and density of aquaculture leases in the area

D. It will not unreasonably interfere with existing ecologically significant flora and fauna in the area

E. The applicant has a source of organisms to culture on the site

F. The lease does not unreasonably interfere with public use of municipal, state or federally owned beaches, parks or docking facilities

Leases are monitored by DMR on an annual basis. If substantially no research or aquaculture has been conducted the previous year or conditions of the lease have been violated, the Commis-sioner shall initiate revocation proceedings and revoke the lease if evidence sustains the con-clusion that violations have occurred.

*** Aquaculture Monitoring Program**. In accordance with 12 M.R.S.A., '6077, the Department of Marine Resources is responsible for establishing and maintaining a comprehensive information base pertaining to all aspects of the siting, developing, and operation of finfish aquaculture facilities within the state. Information is collected and organized in such a manner as to allow effective enforcement of all laws pertaining to finfish aquaculture at individual facilities. Data requirements include the following:

A. Geophysical site characteristics, including currents and bathymetry;

B. Benthic habitat characteristics and effects, including changes in community structure and function;

C. Water column effects, including water chemistry and plankton;

D. Feeding and production data sufficient to estimate effluent loading;

E. Smolt and brood stock introduction and transfer data;

F. Disease incidence and use of chemical therapeutics; and

G. Other ancillary information as the Commissioner may find necessary

Education:

The aquaculture industry will be actively involved in the Education and Outreach Program identified in the Maine Atlantic Salmon Conservation Plan. This program will ensure that the general public and other targeted groups are informed and supportive of the programs to conserve and enhance wild salmon. Education and outreach efforts will include dissemination of information on the aquaculture industry, its significance to the downeast economy, how the industry plays a key role in river-specific stock enhancement and the program to provide aquaculture salmon to recreational fishermen who catch and release wild salmon. The industry will also participate with other groups to provide tours, symposia and other activities as appropriate to educate the public on Maine=s Atlantic salmon aquaculture industry.

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TABLE 1. Potential Impacts on River-Specific Atlantic Salmon Related to Aquaculture-Reared Salmon & Recommended Actions to Reduce Threats

Table 1 is currently not available for viewing.

TABLE 2. Potential Risks to Atlantic Salmon Related to Fish Culture Operations Involving Aquaculture & Ongoing

Table 2 is currently not available for viewing.

ESA/NASCO Aquaculture Working Group of the Governor's Task Force

Report of the Fish Health Subcommittee

Donald E. Hoenig, VMD

Stephen K. Ellis, DVM

Definition of Issue:

Concerns were expressed in the "Status Review for Anadromous Atlantic Salmon in the United States" that interactions between farmed and wild salmon may adversely affect wild stocks. Specifically, the issue before the Fish Health Subcommittee is the potentially deleterious affect of pathogens (bacterial, viral, fungal and parasitic) cited by references in the " Status Review " as being associated with fish artificially propogated under high densities. Conversely, representatives of the aquaculture industry have expressed similar reservations regarding possible transfer of pathogens from wild salmon to their caged counterparts.

Background

- Movement of fish into the State of Maine is subject to the New England Salmonid Health Guidelines which have been adopted as rule by the Maine Dept. of Marine Resources and as policy by the Maine Dept. of Inland Fisheries and Wildlife.

- Maine statute includes a prohibition on the importation or introduction into any waters of the state of any Atlantic salmon, live or as eggs, that originate in any Icelandic or European territorial water, or any other species of salmon, exclusive of rainbow trout, originating west of the North American Continental Divide.

- International importations are regulated under Title 50, U.S. Fish and Wildlife Service.

- The Ad Hoc Fish Health Committee was created in 1994 by the Maine Aquaculture Association to allow for industry input to develop more widely representative and responsive intrastate fish health rules for Maine.

- Accomplishments of the Ad Hoc Conmmittee include:

    1. Critique of the New England Salmonid Health Guidelines

    2. Development of proposed alternate fish health guidelines for Maine

    3. Received a Maine Aquaculture Innovation Center grant to implement a fish health monitoring project for the fresh and marine waters of Maine. The project plans embrace several compents, incuding a retrospective survey of fish diseases occurring in Maine and surrounding waters over the last 10 years, a review and listing of professional and diagnostic health resources available to Maine's aquaculture industry, and a multi-year fish health monitoring project that will collect data from a variety of sources. The purpose of the project is to establish some scientifically sound fish health data on which to base future rulemaking and fish health management strategies and decisions.

    4. U.S. Fish and Wildlife Service and National Marine Fisheries Service representatives added to Committee.

Conclusions

- The State of Maine has some of the most restrictive fish health laws and regulations in the United States. Current statutes and regulations require thorough testing and analysis of fish before they can be imported from outside the state. In addition, fish health testing is also required for permitted intrastate movement of salmonids between inland and coastal waters.

- Maine is currently free of the following diseases: Viral Hemorrhagic Septicemia (VHS) * Infectious Hemopoietic Necrosis (IHN) * Whirling Disease (WD) Ceratomyxa shasta (CS) * Onchorhyncus masou Virus (OMV)* (* NESHG emergency diseases)

- The Ad Hoc Fish Health Ccommittee has submitted to DMR and IF&W a revised set of fish health guidelines for intrastate fish movements.

- Data from the ongoing fish health monitoring project will provide a basis for meaningful risk analysis and guidance for further refinement of health guidelines.

- In the event of introduction or detection of an emergency pathogen at a commercial fish culture facility, a decision to destroy stocks should include consideration of indemnification. Currently, eradication/indemnification strategies are not clearly defined.

- To date, the current sea lice infestation at Maine sea pen sites has been effectively addressed through the emergency authorization for use of a parasiticide. The Maine Aquaculture Association finfish group has agreed to management strategies for the 1996 season which include early treatment and implementation of an integrated pest management protocol overseen by Dr. Mike Opitz and his graduate student from UMO.

- Currently there inadequate mechanisms for the aquaculture industry to provide formal input in the development of fish health rules.

- A scientific working group of North American Salmon Conservation Organization is currently reviewing the fish health section of the North American Commission protocols and will make recommendations on modifications which should be made to the protocols.

- Current and widely used fish management practices employed by the aquaculture industry include at least yearly fish health inspections using an existing infrastructure of certified inspectors to meet permit requirements for fish movements, the use of well-trained personnel at hatchery and pen sites, protected water sources, vaccination of all smolts against diseases commonly contracted in the marine environment, paired mating and 100% lethal sampling of broodstock, splitting of pen populations to control densities, and age grouping at distinct pensites when possible.

Recommendations

- Using the USDA Emergency Disease Eradication Plans as a model, strategies for eradication and indemnification should be developed as soon as possible and certainly prior to the prior to the detection of an emergency disease.

- Findings from the fish health monitoring project should be considered in future fish health rule- and policy-making decisions.

- The fish health regulatory process affecting the aquaculture industry should make provisions for voting representation by the industry.

Atlantic Salmon Task Force

Aquaculture Working Group

Weirs Subgroup Report

by

E.T. Baum, Maine Atlantic Salmon Authority

Gregg E. Horten, Maine Atlantic Salmon Authority

Jerry Marancik, U.S. Fish & Wildlife Service

Ben Rizzo, U.S. Fish & Wildlife Service

Ai Blott, National Marine Fisheries Service

Definitions of Issues

The Draft Status Review for Anadromous Atlantic Salmon in the United States, prepared in January, 1995 by the US Fish & Wildlife Service and National Marine Fisheries Service listed the following perceived threats to wild salmon populations (pp 64-65): AAtlantic salmon that escape from farms may pose a threat to native populations in coastal Maine rivers. The potential for escape and resultant interactions with native stocks is expected to increase given the continued operation of farms and growth of the industry. Because of selection in the hatchery or culture environment, farmed salmon are expected to become less fit for life in the wild. However, there is concern about the potential adverse effects that farmed salmon could have on native stocks should they escape or be released to the wild. In farmed salmon, genetic variability may decrease due to random genetic drift in comparatively small broodstocks; culture or artificial propagation may select for attributes that affect the behavior of farmed salmon. Interactions between farmed and wild salmon may adversely affect wild stocks. The occurrence and spread of infectious diseases may increase due to the high densities at which farmed salmon are raised (Institute of Aquaculture 1988; Lura and Saegrov 1991; Hastein and Lindstad 1991; Mork 1991; NASCO 1993; Utter et al. 1993).

Mork (1991) characterized the potential permanent effect of one generation burst immigrations, resultant from large scale escapes from farms near spawning rivers, on the genetic differentiation among wild stocks. He reported that small Atlantic salmon populations may be most vulnerable to burst immigrations, and these events could be the most significant way in which farmed salmon affect the genetic structure of wild populations. Farmed salmon have been documented to spawn successfully and later in the season than wild salmon (Lura and Saegrov 1991; Jonsson et al. 1991), a factor that increases the potential for limiting the success of wild spawners through redd superimposition.

Disease epizootics in wild Atlantic salmon populations are not common, but in culture operations where fish are artificially propagated under high densities, they can pose a significant threat (NAC 1991; Saunders 1991). Diseases affecting Atlantic salmon reared in captivity include bacterial, parasitic, viral, fungal and nutritious diseases (Olafsen and Roberts 1993). The development of a disease epizootic results from an interaction between the host, environment and the disease agent. In farmed salmon, the occurrence of disease is generally due to the high densities at which fish are reared (Hastein and Lindstad 1991). Bacteria may be released to the environment during and after epizootic diseases and may survive and persist (Olafsen and Roberts 1993; Egusa 1992).@

Background

Most Atlantic salmon farms are located in eastern Washington County, Maine or western New Brunswick, Canada, and it is in the rivers of this area of North America where the majority of aquaculture escapees have been documented. Salmon originating from farming operations have been observed in 8 Maine rivers to date. The incidence of escapees has been highest in the Saint Croix, Dennys, and East Machias rivers. Although not documented in the Machias River, the Maine Atlantic Salmon Authority believes that aquaculture escapees occur with the same frequency as has been observed in the Dennys and East Machias rivers. Only one salmon of farmed origin has been observed in the Narraguagus River (1994); similarly only one has been documented in the Penobscot River (1990). Small numbers of aquaculture escapees have also been observed in 3 eastern Maine rivers which do not contain wild salmon populations and are not stocked (Pennamaquan River, Orange River, Boyden Stream).

The first documented incidence of farmed salmon in Maine rivers occurred in 1990, when a minimum of 17% (14 of 83 fish) of the rod catch in the East Machias River was of farmed origin. While there were few reports of farm origin salmon in Maine rivers in 1991 and 1992, the numbers have been increasing since 1993. For example, in 1993 there were an estimated 20 aquaculture escapees in the Dennys River, which had a documented run of 40 - 50 salmon. In 1994, of a total Dennys River weir catch of 47 salmon, all but 5 were of farmed origin. Additionally, 54% (97 of 181) of the trap catch of Atlantic salmon in the St. Croix River in 1994 was of farmed origin. Preliminary results of 1995 trap catches again indicate a high incidence of farmed salmon (14 of 60 in the St. Croix and 4 of 9 in the Dennys). Farm origin salmon were also apparently caught (and released) by anglers fishing the Dennys and East Machias rivers during 1995.

The highly restrictive sport fishery regulations and low salmon abundance (with resultant low angling effort), combined with the fact that most eastern Maine rivers do not contain fish trapping or counting facilities make quantification of farm origin salmon problematic. Additionally, the overall abundance of wild origin salmon in each river is also unknown. Redd counts conducted by Maine Atlantic Salmon Authority and U.S. Fish & Wildlife Service personnel provide annual estimates of spawning salmon in eastern Maine rivers; however, the origin of these fish cannot be readily ascertained unless scale samples are obtained from individual fish.

The need for permanent, seasonally-operated salmon counting weirs was originally identified in the Prelisting Recovery Plan for Maine Wild Atlantic Salmon Populations, which was prepared by the Atlantic Sea Run Salmon Commission and U.S. Fish & Wildlife Service (Baum, et al. 1992). Fish counting facilities are necessary for the following management activities related to Atlantic salmon recovery efforts in the seven Maine rivers with salmon populations which are predominantly of wild origin (Dennys, East Machias, Machias, Pleasant, Narraguagus, Ducktrap and Sheepscot rivers):

- 1) To enumerate Atlantic salmon entering these rivers and to monitor the number of salmon available for spawning.
- 2) To quantify and assess the extent of aquaculture-origin salmon in Maine rivers.
- 3) To determine the age, origin and run timing of salmon entering these rivers, and to collect biological information from individual fish (length, weight, sex, scale samples, tissue samples for genetics studies, check for marks, tags, injuries, diseases and parasites).
- 4) To collect Atlantic salmon broodstock for future river - specific restocking programs. 5) To prevent entry of and/or remove any non-indigenous stocks.

The Permanent Weirs Subgroup evaluated the following three types of weirs which are universally used to count adult salmon throughout the U.S. and Canada: 1) picket-type weirs (operated by the ASRSC and USFWS from 1992-1995 in the Dennys River, in 1994 in the Pleasant River, and 1994-1995 in the Sheepscot River); 2) resistance board or floating weirs (operated in Japan and Alaska in recent years); and 3) seasonally permanent, conventional (A-frame) weirs.

In order to be effective in capturing the entire salmon run in each river, fish counting weirs must operate continually from early May to early November each year and must be located near the head-of-tide or below major Atlantic salmon spawning and nursery habitat areas. Weir sites should have a wide, uniform cross-section, water depths of 3' - 5' and velocities in the 2 - 3 fps range. Additionally, weir sites should be located in a straight segment of channel (no bends) with laminar flow, gravel substrate which is 1"-5" in diameter, and be easily accessible for construction, operation and maintenance activities. It is imperative that weirs and associated trapping facilities be designed and installed to minimize the likelihood of causing injury (or death) to Atlantic salmon and other species of fish in the river.

A field reconnaissance of the Dennys, East Machias, Machias and Pleasant rivers was conducted in June 1995. Suitable sites for weirs which met the criteria listed above were identified in the lower Dennys River (in Dennysville, near fire hydrant), the lower East Machias River (Gaddis Pool site in East Machias), the lower Machias River (near Jordan=s greenhouse in Machias), and the lower Pleasant River (about 0.5 miles above Route 1). Suitable sites for permanent weirs have not yet been identified for the Ducktrap or Sheepscot rivers. The advantages and disadvantages of the three types of weirs are as follows:

1) Picket Weir

Advantages	Disadvantages
Inexpensive	Susceptible to washing out during high flows; this type of weir has been ineffective in obtaining complete fish counts in Maine rivers
Easy installation	Cannot be installed early in season - must wait for spring flows to subside
Portable	Requires water depths less than 3', a condition not present for larger rivers such as the Machias and East Machias
No permitting required	Intensive maintenance required. Presents a boating hazard

2) Resistance Board (Floating) Weir

Advantages	**Disadvantages**
Some degree of portability	Cannot install until high spring flows have subsided, although earlier than picket weirs
Low maintenance	Possibly ineffective at obtaining complete salmon count; fish may bypass at high flows
Automatic cleaning feature	
Moderate cost	Restricted sites available due to flow, depth, substrate, etc.
DEP (state) permit only requirement	
Can accommodate boating	
Modifiable to capture downstream migrants	Not feasible for large river such as the Machias.
Less vulnerable to high flow events than picket weirs	Many articulating parts which can bind.

3) Standard (Conventional A-Frame) Weir

Advantages	**Disadvantages**

Would provide complete fish counts	High capital cost
Could be modified to capture downstream migrants	High operational and maintenance costs
Most reliable and effective fish capture facility	State (DEP) and Federal (Army Corps) permits required
	Boating hazard
	Permanent concrete (or timber) crib foundation required

The USFWS, through the 3-year AStewardship Program@ which began in 1994, financed the construction costs for a resistance board weir which was installed and operated by the Atlantic Salmon Authority on a trial basis in the Dennys River in the fall of 1995. Fabrication and installation of the facility was accomplished through Project SHARE. The weir is scheduled to be operated by the Atlantic Salmon Authority and USFWS on a full-time basis from May 1 to early-November in 1996.

Conclusions

Portable, picket-type weirs are ineffective in providing complete salmon counts, and their use is precluded on larger rivers, therefore the Subgroup does not consider them to be a viable option. Since there are no aquaculture facilities in close proximity to the Ducktrap and Sheepscot Rivers, the need for weirs on these rivers is a lower priority. Although resistance board weirs are less costly to install and operate, it may be possible for adult salmon to bypass the weir during periods of high flow. Additionally, due to the physical size and other characteristics of the Machias River, installation of a resistance board weir is not feasible.

A weir is not necessary on the Narraguagus River at this time, since the existing Atlantic Salmon Authority permanent fish trapping facility at the ice control dam fishway in Cherryfield should be suitable for the foreseeable future.

Recommendations

1. We recommend that a standard (A-frame) weir be installed on the Machias River.

2. We recommend that the existing resistance board weir be operated for one full field season (1996) on the Dennys River.

3. A decision on which type of weir to install on the East Machias and Pleasant Rivers (standard vs resistance board) should be made after the full year of operation of the existing Dennys River weir.

4. We recommend that the Atlantic Salmon Authority continue to annually monitor the entire Narraguagus River salmon run utilizing the existing fishway trapping facilities in Cherryfield.

5. While the need for permanent weirs on the Ducktrap and Sheepscot Rivers is of lower priority, we recommend them for fishery management purposes. Picket-type weirs, operated on a short-term basis may be satisfactory for this purpose on an interim basis.

Estimated Costs

Preliminary, estimated costs for resistance board (floating) and standard (A-frame) weirs for the Dennys, East Machias, Machias and Pleasant Rivers are presented below. Conceptual plans and detailed construction cost estimates for the Dennys, East Machias, and Machias weirs (both types) are presented in Appendix I.

Table showing Cost estimates (based upon 1996 price levels) for standard (A-frame) and resistance board (floating) weirs on various Maine rivers (listed in order of priority) is currently unavailable for viewing.

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APPENDIX I

This Appendix is currently not available to view.

Conceptual Plan - Machias River Standard Weir

Conceptual Plan - Resistance Board Weir

Construction Cost Estimate - Machias River Standard Weir

Construction Cost Estimate - Machias River Resistance Board Weir

Construction Cost Estimate - East Machias Standard Weir

Construction Cost Estimate - East Machias Resistance Board Weir

Construction Cost Estimate - Dennys River Standard Weir

Construction Cost Estimate - Dennys River Resistance Board Weir

Atlantic Salmon Task Force

ESA/NASCO Salmon Aquaculture Working Group

Marking / Tagging Subgroup Report

by

L.N. Flagg, Maine Department of Marine Resources

E.T. Baum, Maine Atlantic Salmon Authority

Jerry Marancik, U.S. Fish & Wildlife Service

Don Hoenig, Maine Department of Agriculture

Steve Ellis, USDA, APHIS

Definition of the Issue:

In January, 1995, the U.S. Fish & Wildlife Service and National Marine Fisheries Service released the *Draft Status Review for Anadromous Atlantic Salmon in the United States.* This Status Review identified Atlantic salmon that escape from farms as a potential threat to wild salmon populations. These potential threats may result from a number of interactions between farmed and "wild" salmon. In order to minimize interactions, it is necessary to be able to distinguish between wild and aquaculture fish. An easily identifiable mark on aquaculture salmon, coupled with weirs on salmon rivers, would provide an important tool to prevent interactions between wild and farmed salmon.

Background:

"The first documented incidence of farmed salmon in Maine rivers occurred in 1990 when a minimum of 17% (14 of 83 fish) of the rod catch on the East Machias River was of farmed origin" (Baum et al, 1996). In subsequent years, farmed salmon were also identified in the Dennys, St. Croix, Narraguagus, and several New Brunswick rivers. The major issue of concern is how to specifically identify aquaculture escapees since wild salmon cultured for release as smolts may also exhibit some external characteristics of farmed salmon, such as eroded fins. In addition, farmed salmon that escape as early postsmolts from sea cages may survive at sea and return as adults and appear to be "wild" salmon. Farmed salmon that escape as adults may be easier to identify from general body shape as well as fin ray variation. The identification of farmed salmon escapees could be enhanced if all farm-raised fish were marked or tagged with a universally recognized system. There are a variety of methods of marking and/or tagging fish ranging from external tags to fin clips to food additives (tetracycline) to internal tags (coded wire tags or elastomer tags), radioactive markers, immersion staining, or cold branding. A number of impediments to overcome in developing a universal marking system for farmed salmon are the following:

- Marking/tagging would add an additional cost to the aquaculture industry and some methods lower the market value of farmed fish
- Currently no fin clip or other mark has been reserved exclusively for aquaculture use (marks, clips and tags are used in numerous field studies of wild and hatchery salmon released to the wild)
- Any agreed upon mark should be mandatorily applied to all aquaculture salmon in Maine and eastern Canada, although unilateral marking of Maine fish would provide some benefit in identifying aquaculture-reared salmon
- Fish marking requires additional handling that may induce additional mortality loss due to trauma from handling

On-Going Research:

Research on a number of marking techniques continues at state, federal and private facilities. Marking techniques being tested include temperature-induced otolith marks, immunological tags, genetic markers, elastomer implants, flourescing marks from treatment with such compounds as strontium chloride, pigment, and immersion in tetracycline or calcein.

The Value of Marking:

It is likely that fish entering the Washington County rivers would come from several sources (river origin, aquaculture escapees, intentional releases of pen-reared fish). One of the primary strategies of the Aquaculture Working Group is to minimize impacts of aquaculture-origin fish on native populations by restricting their entry into the river systems. The development of weirs for this purpose has been given high priority by the Task Force and program personnel.

The ability to determine the origin of salmon entering the river by readily detectable marks would be useful to make this process more effective. The mark should, at a minimum, be easy and economical to apply and detect, not adversely affect survival or marketability, and can be very specific or general as to the origin of the fish.

The ability to differentiate between river-origin and pen-reared fish observed in a weir, angled, or on the spawning grounds would allow managers to 1) separate fish entering a river according to origin, thus controlling the numbers and destination of the various stocks; 2) regulate the sport fishery; 3) evaluate the success of a program where pen-reared adults are intentionally released into the river; 4) determine the proportion of naturally produced fish in the run, evaluating the status of the native stocks; and 5) evaluate other parameters such as fall-back from trucked adults, strayings, reproductions etc.

The following cost information was based upon marking programs undertaken at the Craig Brook and Green Lake National Fish Hatcheries):

This information is currently not available for viewing.

These costs reflect only the cost of tags and taggers with no costs shown for miscellaneous, supplies, or manpower to support the marking program. Significant savings can be made by purchasing tags in large quantities. Carlin, CWT, and fin clip costs are based on long experience with costs associated with mass marking. Elastomer tag costs are based on recent experience with experimental scale marking of fish.

Conclusion:

A universal marking system for farm-reared salmon that is cost effective, safe, easy to apply, durable, and readily identifiable has not been developed. Additional research on cost effective mass marking techniques might yield a solution to this problem. There are current techniques that provide adequate substitutes for universal marking of farmed salmon. Analysis of scale samples can be used to differentiate farmed salmon from wild fish. The current emphasis on fry stocking as a restoration technique and de-emphasis on smolt stocking of "wild" salmon should minimize the confusion between farmed vs wild salmon. Comparative analysis of the flesh of wild vs farmed salmon may also show discrete differences due to dietary differences.

Recommendations:

- Verify existing techniques (scale sample analysis) for differentiating between wild and farmed salmon

- Priority should be given to development of a process to mark fish with a visually identifiable mark that would be applied concurrently with the existing aquaculture vaccination process

- Evaluate available marking methods to identify those that appear promising and followup with testing and economic/market impact evaluation of those most likely to succeed

- Recommend that the ATS Task Force set up a workshop between the U.S. and Canadian governments and aquaculture industry representatives to identify and implement coopera-tive programs to address the impacts of interactions between cultured and wild Atlantic salmon stocks in the Gulf of Maine.

ESA / NASCO SALMON AQUACULTURE WORKING GROUP COMMITTEE REPORT RIVER-SPECIFIC STOCK REHABILITATION

Subgroup Report

by

Chris Frantsi, Connors Aquaculture
Eb Baum, Maine Atlantic Salmon Authority
Paul Gaston, USFWS
Gary Donovan, Champion International
Tim King, National Biological Services
Jerry Marancik, USFWS
John Thoesen, USFWS
John Kocik, NMFS
Don Hoenig, Maine Department of Agriculture
John Albright, Atlantic Salmon Federation

DEFINITION OF THE ISSUE

The numbers of salmon in the seven Maine rivers are at such low levels that intervention is necessary to recover the stocks to sustainable levels.

This committee has designed a program to increase the number of river-specific salmon returning to the rivers. This program is designed to rehabilitate the river specific stock to sustainable levels. This increase in number of salmon should have an added benefit of reducing the impact of non-river specific stock and aquaculture escapees..

BACKGROUND

Native Atlantic salmon populations in seven Maine rivers currently have critically low population hlevels. These rivers are the Dennys, East Machias, Machias, Pleasant, Narraguagus, Ducktrap and Sheepscot.

Studies in these rivers have shown that inadequate spawning escapement is the limiting factor in the population status rather than available freshwater habitat. Therefore increasing the number of spawners is an important early step in conserving and rehabilitating these stocks.

The River-Specific Stock Rehabilitation Committee

The **River- Specific Stock Rehabilitation Commitee** was formulated as an **Action Item Team** to coordinate the **rehabilitation** of ***viable** populations of Atlantic salmon in selected Maine rivers.

* **Viable** - at a population quality and level:

1.(firstly) allowing it to be self-sustaining, and

2. (secondly) providing a surplus to allow a public recreational fishery.

The Committee

The Committee utilizes a wide range of expertise from public and private sectors including the aquaculture industry, state and federal agencies, salmon angling and other conservation groups and consists of the following individuals: (addresses appended)

Chris Frantsi (Chair)(Industry)	Jerry Marancik (USFWS)
Ed Baum (ASA)	John Thoesen (USFWS)
Paul Gaston (USFWS)	John Kocik (NMFS)
Gary Donovan (SHARE)	Don Hoenig (MDA)
Tim King (NBS)	John Albright (ASF)

The Program in General

The Committee designed a program to conserve and rehabilitate the stocks as outlined following:

a. Utilize existing stocks, collect necessary stocks from selected rivers and/or utilize stocks which may currently be held in federal facilities (adults/parr/fry).

b. Rear these stocks from egg to smolt in participating government and private hatcheries.

c. Complete the smoltification process in hatcheries and/or temporary holding sites on the river of the stock origin (this will imprint the stock on the specific river).

d. Transfer the smolt into marine cages located in estuaries near the river.

e. Grow the smolt to pre-maturity (16-32 months) when fish in excess of hatchery need are released near the river mouth to allow migration up the river. Broodstock may be held for spawning.

f. Establish milestones and targets to insure the program does not become self perpetuating.

g. Development of a cooperative agreement clearly outlining the responsibilites and duties of all parties involved.

Rehabilitation Targets

The committee established target numbers of salmon for each river in the program as follows:

1. The adult escapement required to provide sufficient spawning stock to fully utilize the juvenile habitat in each river.

2. The number of fish required to provide a recreational fishery similar to that regarded as a "good" (recent historical) catch for the river.

The following table defines the problem and establishes targets for the rivers in the program.

RIVER	*BASE STOCK	REC. STOCK	CURRENT STATUS	TOTAL NEEDED	% OF TOTAL
Dennys	170	100	10-50	270	5-20%
E. Machias	150	50	20-50	200	10-20%
Machias	450	150	75-150	600	15-25%
Pleasant	70	25	5-25	95	5-25%

Narraguagus	400	100	50-80	500	10-20%
Sheepscot	200	25	20-40	225	10-20%
Ducktrap	40	20	20-40	65	30-60%

Legend:

Base Stock - The number of spawners whose progeny will fully utilize freshwater nursery habitat. This level of fish may sustain the run but will not provide a recreational fishery.

Recreational Stock - The adult fish required to provide a recreational fishery similar to that experienced historically.This is the number in excess of required spawning escapement.

Current Status - The estimated number of adult returns observed in recent years.

Total Needed - The minimum number of returning salmon necessary to fully utilize spawning and nursery habitat and allow a recreational fishery.

% of Total - Present adult numbers relative to total target.

THE PROGRAM IN DETAIL
Issues to be addressed (+assumptions)

* The primary emphasis of the program is conservation and stock enhancement with the fishery being a benefit rather than a primary goal.

* The program must have a finite life with targets and milestone reflecting this.

* The program must incorporate both biological and administrative details.

* Significant technical issues must be reconciled by the committee.

* The plan must be presented in a form allowing comprehension by administrators, anglers and the general public.

* Designation of target rivers - Proposed -(7)- Dennys, East Machias, Machias, Pleasant, Narraguagus, Sheepscot and Ducktrap.

* Designation of estuaries and associated aquaculture marine rearing areas.

* Designation of hatcheries and or smolt/ parr rearing areas associated with each river.

* Summarization of existing stocks available and development of plan to collect suitable stocks.

* Preparation of Rearing Program
    - Determination of stock needs
    - Collection of Stock
    - Rearing of Stock
    - Egg thru parr
        Smoltification
        Marine Smolt to Brood Stock
    - Release Procedures and Sites

* Design and Implementation of Associated Programs
    - Fish Health Program
    - Collection and Analysis Program
    - Fishery Management Program

* Other issues to be addressed including:
  - details of operation such as where the program will be conducted, who will do the work... - who will pay for the program
  - what is the fall back position

Specific River Programs

A number of factors affect the choice of program for specific rivers as follows:

- availability of river specific stock
- current status of the stock in the river.
- ability to install monitoring and recording systems
- presence of existing programs

An example of a **Full Program** can be described as follows:

Wild broodstock are collected from specific rivers and/or existing programs and transferred to state and federal hatcheries for holding and spawning.

Eggs are held in government or private hatcheries and reared to various stages.

Fry/Parr as well as S1 and S2 smolts are released into the river of origin.

S1 and S2 smolts are taken to the river in spring where they are held if feasible in imprinting facilities (if a hatchery does not exist on the river).

The imprinted smolts are transferred by floating barge (to further imprint on the river system) and transported to aquaculture cages in the specific estuary. If an aquaculture operation does not exist on the specific estuary, either a close one will be selected or a dedicated facility could be established in the area.

The aquaculture stocks will be released in 24 to 32 months (12-16 Lb) near the mouth of the river to migrate up river to contribute to both the fishery and the spawning population. Alternatively broodstock may be trucked directly to headwater spawning areas in early October.

The upriver movement of fish will be monitored and controlled using river fences. This will in part be necessary to prevent the domination of the river system with one component of the stock.

The program will continue annually utilizing spawners which are wild and have undergone marine survival selection.

Programs by River

The following rivers and the planned programs are as follows:

Dennys - Full Program will be initiated Spring 1996.
Machias - Full Program will be initiated Spring 1996.
Narraguagus - Full Program will be initiated Spring 1996.
Pleasant - Ongoing Fry Stocking Program.
East Machias - " " " "
Sheepscot - " " " "
Ducktrap - No planned program.

There is more information for this section that is currently unavailable for viewing.

Points for Additional Consideration

1. The rehabilitation program can be expanded or the recreational fishery diverted to remove pressure from program rivers by the use of river-specific,imprinted and cage reared releases in non-program rivers such as the Penobscot.

2. The impact of the "fry" stocking program can be expanded by extra production from industry hatcheries.

3. Alternative plans must be established in the event problems arise in implementation or success of the primary program(s).

Establishment of Targets and Milestones

No program will be successful without the establishment of targets and milestones for measuring success. Targets can be things such as numbers of fish returning to rivers, improvement of habitat or the implementation of programs. Milestones are measuring-posts along the way.

Suggested Milestones

1. January 1996 and each January thereafter: Have successfully executed all programs.

2. Have increased wild adult returns by set amounts in each river and increasing each year as follows: Note: the recreation quotient can be satisfied earlier using combined aquaculture and wild fish:

Target Adult Returns By Year - Base (Added)

The table showing the Target Adult Returns by Year - Base (Added) is currently unavailable. Pl

CONCLUSIONS

A strong program should be implemented as soon as possible to rehabilitate the river-specific stocks. The committee feels that the program will successfully rebuild the stocks in question.

The participants in the program should identify and commit resources necessary to implement the program immediately.

For this program to be successful strong central coordination is required.

RECOMMENDATIONS

1. Program approval be sought.

2. Program responsibility be defined. This should incorporate a role for local clubs/volunteers and other willing contributors to the program.

3. Program funding be identified.

4. Program scheduling be established.

5. A cooperative agreement be developed for all parties.

ESTIMATED COSTS

Assumptions

Assume weirs are located on lower portions of all rivers with Full Program.

Cost is based on a single river (eg.Dennys) program assuming 10,000 eggs (start January)

8,000 smolts (7000 released in wild)

1,000 adults (balance of smolts from above)

Smolt Rearing @ 2.00 ea			16,000
Fish Health			5,000
Imprinting			5,000
Cage Rearing 30.00 X 1,000			30,000
Marking -	Smolts -	1,000	
	Adults -	2,000	3,000
Stocking -	Smolts -	1,000	
	Adults -	2,000	2,000
Coordination / Evaluation			100,000
		Total	**$161,000**

Atlantic Salmon Task Force
Aquaculture Working Group

Loss Control

Subgroup Report

Joseph McGonigile, Maine Aquaculture Association
Steve Swartz, Kennebec Aquaculture
David Miller, Penobscot Salmon Farms

DEFINITION OF THE ISSUE:

Cultured salmon can escape from aquaculture grow-out sites and a limited but positive number may survive in a feral state. Survivors which persist in reasonable geographic proximity to the escape site and survive to maturity may migrate into fresh water river systems where the potential exists for interactions with naturally-spawned stocks. Such interactions include increased competition for food and habitat, direct inter- breeding and disruption of wild redds. The purpose of this report is to document the loss control parameters that operate on commercial Atlantic salmon aquaculture in Maine and to identify the techniques and equipment used by or available to the industry that minimize the potential for escapment.

BACKGROUND:

Experimentation with salmonid aquaculture occurred at several sites in Maine throughout the 1970s, which created a pool of technical competence oriented toward adaptive husbandry, such History and as the use of site-built equipment and reprocessed fish wastes feed. By the 1980s, the New Brunswick provincial government's success in demonstrating the economic viability of salmon aquaculture under Gulf of Maine conditions helped usher in the first phase commercialization in Maine. Initially, a single farm tapped both the adaptive tradition of Maine's experimental era and the breakthrough innovations of Norwegian net-pen husbandry to launch the Maine industry in 1982. Employees of that original farm spun out new operations in the mid-1980s, continuing the dual tradition of Norwegian science and Maine adaptation. In 1986, large scale commercialization began in Maine, based on direct technology transfer from Norway. Through the ensuing decade, production grew from 1-million to 22-million pounds per year, while the number of farms declined from 18 to 12 by 1996. During the same period, market prices fell by more than 50 percent.

More than 90 percent of Maine Atlantic salmon production is concentrated in the Cobscook and Machias bay regions, with the remaining production located off Great Wass, Swan's, and Mt. Desert islands. While several small and large farms have exited the industry since the late 1980s, leaseholds, stock and equipment have typically been transferred to success or organizations, limiting the need for new site development as the industry has transitioned from a period of rapid growth to the current phase of stable commodity production. Only 8 new lease sites have been developed during the decade, up from 18 sites in 1989.

While site development has remained moderate, cage numbers, sizes and quality have undergone a more considerable change. Bettencourt and Anderson (1990) identified 355 sea cages in operation in Maine in their comprehensive 1989 survey of the industry for USDA's Northeastern Regional Aquaculture Center. A 1995 survey by University of Maine veterinarian, H. Michael Opitz, for FDA therapeutant trials identified 772 cages in place, an average increase of 16 percent per year. The most dramatic change evidenced between the two surveys is a shift to the use of modern, large diameter, poly circular cages of Norwegian manufacture, which increased from 12 to 149. Another 24 small diameter, poly circles were also deployed in the period, up from 0 in 1989. The cage of choice remains 12 and 15 meter steel squares manufactured in New Brunswick, which increased from 284 to 546 between the surveys. A small remnant of the industry's adaptive roots remains in approximately 10 site-built 10 meter wooden cages still in service, down from 36 in 1989. Finally, site intensity has increased as industry consolidation has eliminated the smallest farms, from an average of 21 cages per site to 30. The majority of farms deployed between 4 and 12 cages per site in 1989; the majority deployed between 9 and 40 in 1995.

Production volume has continued to increase, but at a radically reduced rate of growth after 1991, the peak year for industry expansion. The growth rate has continued to decelerate through the mid-decade and appears likely to stabilize around five percent per year by the end of the century, a rate typical of commodity agriculture. Compared with the 1995 projections developed in the Bettencourt and Anderson survey, only 44 percent of a projected 59 farm sites are in production, and volumes have reached only 80 percent of the 26.5 million pounds projected in 1989.

Discussion

The economics of salmon culture in the 1990s require grow-out operations to actively minimize inventory losses. Since disease, predation and climatic conditions, over which growers have only limited control, account for 80 percent of these losses a powerful economic incentive exists for farms to focus on escape control and to hold escape losses to an absolute minimum (Mitchell, McConnell, Daniels: 1994). As market prices continue to deteriorate toward the cost of production, nine sales are now required to recover the investment lost in the escape of a single harvestable fish, and five are required to recover from the loss of a 1SW. At these ratios, farms or sites that experience significant or repeated losses will no longer survive. Escapes can occur as a result of net damage, cage capsizement, jump net displacement, mesh size error and faulty handling. Escape conditions may be created by events either within or beyond the control of the grower. Uncontrollable events represent the most important source of escape conditions, due both to the limited opportunities they present for preventative intervention and to the potential severity of the damage that can result. The principal uncontrolled sources of escape conditions include:

* Net or cage system damage or displacement during storms

* Net damage from snags by drifting ice or marine debris.

Partially controllable events may be susceptible to incidence reduction efforts by growers.
These include:

* Net damage associated with snags by commercial draggers

* Net damage associated with seal attack.

Controllable events represent a secondary source of escape conditions. Preventative industry practices and the immediacy of event awareness can be expected to limit the potential damage associated with controllable events, which include:

* Net failure associated with tidal stress, chaffing, anchor release, UV exposure, rigging failure, equipment quality or maintenance practices

* Incidental losses during cage transfer, handling or harvest

* Improperly sized netting on smolt receiving cages

Escape control efforts are directed at controlling three general sources of risk: storm damage, other threats to equipment and fish, and handling losses. The following discussion of standard industry practices was developed through full-day interviews and site visits with individual growers representing 5,000,000 pound, 1,000,000 pound and 500,000 pound operations typical of the farm size distribution of the Maine industry. Descriptions of escape control procedures were then circulated to all salmon growers in the Maine Aquaculture Association for review and correction. Follow-up calls and discussions were conducted with all reviewers.

Storm Damage Controls:

* Site Selection: Grow-out sites are selected to control for exposure to prevailing winds, storm paths and exposed seas. Sites are typically located in protected coves or on the lee sides of islands, peninsulas or other land forms.

* Storm Preparation: Pre-storm inspection of rigging, bridles and fasteners; boats and other objects susceptible to release and drifting during storms are removed from cage vicinity. Where storm direction and severity warrant additional assurance, boats and drift-prone equipment relocated away from the site.

Equipment Integrity Preservation

Technology choice is site specific and depends on site conditions and on production levels. However, growers actively investigate new cage technologies as they become available and regularly site-test new systems. Information about system experience and test results is shared informally. The Maine Aquaculture Association is developing a formal exchange process.

* Net Construction: 210/40 to 60 grade line is standard for smolt containment, and 210/60 to 100 grade is standard for use with 1SW and market size fish. There is a general movement toward the use of heavier twine grades as nets are retired and replaced; however, net grade must be paired with cage size in order to meet a maximum weight constraint. Technical improvements in polymer and fiber strength and durability, and a shift from knotted to knotless construction, have improved net performance at all grades and have extended net life from two years to more than five. UV stabilized materials and rip-resistant construction techniques are currently being innovated in the net supply industry for future deployment.

* Cage Maintenance: Nets are typically numbered and tracked by manufacturer, location, date installed, length of service, and dates of inspection and maintenance. Although regimes are site specific and will reflect a specific production strategy, standard procedures include:

* Regular, often weekly, inspection dives covering nets and chaff points

* Repair during inspection

* Semiannual inspection dives of rigging, anchors, lines and bridles; removal of marine growth from chaff points

* Additional inspections of nets and rigging after major storms

* Annual cleaning and comprehensive net inspections

a) on shore where production strategy maximizes equipment productivity through variable density stocking and periodic stock splitting;

b) in the water where production strategy maximizes labor productivity through constant density stocking and handling minimization. Haul out and shore inspection then occurs biennially when nets are changed at the start of a new production cycle.

* Gear Conflict: Snags associated with commercial scallop and urchin draggers are among the most significant threats to mooring, anchor and net integrity. State law restricts dragging within 300 feet of an aquaculture site.

* Seal Deterrence: Seal attacks account for approximately half of all inventory losses, and at least one quarter of all net failure. Control strategies include double bottom nets, perimeter curtains and acoustic seal deterrents, depending on site conditions and risk of attack. These controls lose effectiveness rapidly, however, as seals learn of the presence of fish at a cage site, discount the actual threat of acoustic broadcasts and discover how to breech net systems. Lethal seal takes are no longer permitted for deterrence.

Handling Loss Control

* Handling Reduction: Handling produces stress in fish, which affects growth rates and susceptibility to disease, and may create potential opportunities for incidental escapement. Size grading at the hatchery is now a standard practice in the industry, which has virtually eliminated the need to grade fish in sea cages before harvest. Stock splitting techniques also emphasize reduced handling through seined or pumped transfer.

* Harvest Management: Harvesting techniques include hand netting, pumped transfer and braille transfer from sea cages to barges rigged out as killing floors. Fish are transferred in enclosed nets or pipes, anethesticized with CO_2 to minimize activity, and killed immediately.

Analysis

Because no cage system can provide absolute security, some straying of aquaculture stocks is expected, despite loss control efforts designed to minimize escapement. The presence of newly escaped salmon in the marine environment, however, is only indirectly related to the potential for interactions between strays and naturally spawned populations. Other interactions of concern, which include food and habitat competition, interbreeding and redd disruption, are restricted to the fresh water environments of the seven rivers. Because the fish stocked in commercial sea cages are vaccinated against the most significant salmonid diseases endemic to Maine waters, are treated for the removal of sealice and are subject to more stringent health regulations than are the hatchery stocks from which the rivers-specific populations are derived, the transmission of disease or parasites from strays to naturally-spawned populations is unlikely.

Before marine strays can develop a significant potential for freshwater interactions with river-specific stocks, predation losses and feeding migrations will substantially reduce the feral population available for maturation. Maturation is, in turn, the basic precondition for any significant migration of surviving strays into fresh water. Whether strays will survive to maturity at a rate sufficient to affect the genetic integrity of river-specific stocks is not known. Clearly, however, the closer a stray is to maturity at the time of escape, the greater will be the potential for full maturation and the risk of interbreeding . The age of a stray and the time of escape, therefore, can be seen as the key determinants of interaction potential.

Although the rates of escapement and feral attrition are not known, cyclical patterns of production, weather and seal attacks interact with sufficient definition to allow identification of the age classes present in the water at periods of the greatest escape risk.

The Atlantic salmon production cycle moves through five age classes over a period of 28 months. Smolts are placed in sea cages from mid April through mid-June of the first year. From July through the following March, post-smolts grow into 1SW fish, and during the second April, smolt placement begins a second, overlapping production cycle. By September and October of the second year, the first year class reaches market size marking the start of the harvest. Intensive harvesting occurs through January, when more than 70 percent of the first year class will have been removed from the water. Another 10 to 15 percent of the year class are removed by March, and the remaining 2SW fish are harvested into the summer as market prices and maturation rates dictate.

Superimposed on this production cycle, a seasonal pattern of weather-related escape conditions has been tracked in Mitchell, McConnell, Daniels (1994). MMD, a New Brunswick insurance broker with a dominant position in the Passamaquoddy/ Cobscook bay aquaculture market on both sides of the border, tracks loss claims by month from all sources. While MMD's client base is not universal, and therefore inappropriate for direct tabulations of losses, a significant fraction of the total Cobscook Bay production is captured in the 48-firm data set, providing a large sample of the grower population from which the relative proportion and timing of losses may appropriately be inferred.

The MMD data for the period between 1987 and 1994 show a consistent annual pattern of weather damage and seal attacks concentrated in the winter months, with the worst damage occurring in March, when 75-to- 80-percent of market size fish-- those nearest to maturity and holding the most significant potential for interactions with wild stocks -- have already been harvested. In the overlapping production cycle, post-smolts are also present in the sea cages during the period of highest loss incidence. The period corresponds to the life cycle transition in these juvenile fish from post-smolt to 1SW, still at least 18 months from sexual maturity and the stage of significant potential for interaction with wild populations.

The following table summarizes the interaction between loss incidence rates and the commercial production cycle:

MONTH	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**JAN**	**FEB**	**MAR**
% of Losses	11	0	0	0	4	4	4	4	11	16	16	31
Cycle 1	1sw	1sw	1sw	1sw	1sw	9Mkt	.75M	.6M	.45M	.3M	.25M	.2M
	S/	S/	S/									
	.15M	.1M	pS	pS	pS	pS	pS	pS	pS	pS	pS	1sw
Cycle 2	S	S	S	pS	pS	pS	pS	pS	pS	pS	pS	1sw
	1sw	1sw	1sw	1sw	1sw	9Mkt	.75M	.6M	.45M	.3M	.25M	.2M

Smolt (S); Post-smolt (pS); 1 sea winter (1sw); Market(Mkt); Percent of Mkt. fish remaining (nM)% of Losses measures MMD claims incidence for storm, equipment failure and predation losses only

The interrelationship of weather and production patterns serves to concentrate escape potential on the post-smolt age class as the transition to 1SW occurs. In a feral state, this age class presents virtually no potential for food or habitat competition with naturally-spawned stocks due to the marine feeding behavior characteristic of the class. While naturally-spawned post-smolts and 1SWs associated with the seven rivers would have already completed their migration to Labrador Sea feeding grounds, aquaculture strays at this life stage would be expected to follow one of three possible behavioral strategies -- delayed Labrador migration, local migration offshore, or persistence within the escape embayment. None of these possible strategies would bring strays into contact with naturally-spawned populations exploiting the same food or habitat resources.

Prior to maturation, juvenile strays following any of the three possible strategies would be exposed to substantial attrition from seal predation, with the greatest losses likely to deplete those remaining near the cage sites, where exposure to harbor and grey seal populations accustomed to preying on caged and stray stocks would be most intense. Bay strays that survive could pursue prey into the lower reaches of neighboring rivers on occasion, where they could encounter naturally-spawned smolts feeding on an entirely different class of aquatic life. Some bay strays might also attempt to participate in spawning runs into the rivers but would be incapable of interbreeding with mature wild stocks. Some risk of redd disruption, however, may exist with respect to the immature run participants. Of the original number of strays, however, this risk is limited to those that(a) remain in the escape embayments, (b) survive predation, (c) participate prematurely in spawning runs and (d) investigate redds. Even at this point, investigative behavior must also be disruptive before immature mortality could actually occur.

Due to the radical reduction of cage populations during harvest, a significantly lower escape potential also exists for market size fish as the transition to 2SW occurs. Strays at this life stage --the most valuable and therefore the most protected from a commercial perspective -- would face 6 to 12 months in a feral-10-state prior to the onset of sexual maturity and between 8 and 20 months before full participation in spawning. Fish in this age class would be unlikely to begin a Labrador migration but would otherwise face similar migratory and predation conditions to those faced by the younger age class. The potential for genetic interactions between cultured and wild stocks is limited to the survivors in this age class that succeed in finding a one of the seven rivers.

CONCLUSION:

Consolidation within the Atlantic salmon aquaculture industry and shrinking profit margins provide the capability and a powerful economic incentive for producers to hold escapement to an achievable minimum. The development and deployment of improved containment technology, increasingly rigorous husbandry practices and existing regulatory oversight of site selection, fish health and gear conflicts supplement the economic incentive driving producers to minimize escapement.

The potential for interactions between aquaculture strays and naturally-spawned populations are both only indirectly related to the incidence of escapement and the initial number of strays in the marine environment. Predation losses, other sources of mortality, and behavioral activities related to migration, homing success and choice of river entry all reduce the statistical likelihood that a specific escapement episode will result in individual losses.

The interaction of weather and production patterns concentrates the preponderance of potential strays in the post-smolt/1SW age class, and substantially reduces the potential that market-size and 2SW fish might escape in significant numbers. The situation maximizes the amount to time the average stray will be exposed to attrition in the marine environment prior to the onset of maturity. Few interactions are likely between naturally-spawned populations and the cultured juveniles at the greatest risk of escape.

RECOMMENDATIONS:

1. The industry will work with the University of Maine Cooperative Extension Service to develop adopt a Code of Practice designed to identify best practicable management and best practicable technology available to farms at the 5,000,000 pound, 1,000,000 pound and 500,000 pound levels of production The Code would provide the basis for a voluntary Quality Control program that would certify producer compliance with appropriate technical, husbandry, and repair and maintenance standards that minimize the risk of escapement and disease outbeak.

Cost: $10,000 for development and $3,000 for annual compliance inspections. Source: Development funding has been requested from USDA under the 1996-97 Northeast Regional Aquaculture Center Extension grant. Compliance funding has been requested from the Maine Aquaculture Association.

CITATIONS:

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Atlantic Salmon Task Force
Aquaculture Working Group

Animal Damage Control (Seals)
Subgroup Report

Matthew Scott, Maine Department of Inland Fisheries and Wildlife
Lewis Flagg, Maine Department of Marine Resources

Definition of the Issue:

The focus of the Aquaculture Work group is on eliminating or reducing the interactions between wild and pen-reared Atlantic salmon. Interactions can result in genetic, health or habitat impacts which introduce the possibility of fish mortality or habitat loss. The clearest and most direct way to eliminate interactions is to ensure that the aquaculture fish are not released accidentally or intentionally from the pens. This is an obvious goal for the industry. To address this goal the Aquaculture Work group created subgroups to address cage design and management practices to reduce the potential for release of cultured fish during operational activities such as moving fish into or between cages as well as damage to cages caused by storms. The charge to this particular subgroup was to examine the potential for impacts to wild salmon caused by seal attacks and damage to pens.

Background:

The salmon aquaculture industry began in Maine in the early 1970's and increased significantly during the 1980s. The current Atlantic salmon aquaculture industry is centered in the Eastport-Lubec region of Maine. Cobscook Bay is a suitable site for the pen rearing of salmon for a number of reasons which include high water quality, powerful tidal flushing, storm protection, and relatively moderate water temperatures.

The Gulf of Maine is populated by harbor seals (*Phoca vitulina concolor*) , gray seals (*Halichoerus grypus*), harp seals (*Phoca groenlandica*), hooded seals (*Scystophora cristata*) and ringed seals (*Phoca hispida*). Harbor and gray seals, the most abundant seals in the Gulf of Maine, are opportunistic feeders eating a range of prey including alewife, capelin, cod, clam, flounder, haddock, hake, herring, mackerel, ocean pout, pollock, redfish, sand lance, scallop, salmon, sea raven, shad, shrimp, smelt, squid, tautog and wolfish. Regional populations of both harbor and gray seals have grown substantially in the last decade.

As both the aquaculture industry and the seal populations have increased, the stocks of wild Atlantic salmon have decreased dramatically. The three factors - aquaculture, seals and wild salmon - can interact in a number of ways. Seals are opportunistic feeders and consequently do eat wild salmon impacting the populations. This problem can be exacerbated in areas such as below weirs or at natural narrow channels at river mouths. The loss of any adults Atlantic salmon on the last portion of their migration to the spawning grounds is a significant one. Atlantic salmon examined at traps or by fishermen have been found to exhibit evidence of seal bites. Given the depleted state of the wild Atlantic salmon runs, the subgroup feels the issue of seal predation on the wild fish is a significant one that warrants further investigation. The subgroup has forwarded this recommendation to the Governor's Task Force and consequently will focus the remainder of this report on the potential for seals to damage pens releasing pen reared fish which subsequently then can interact with wild fish.

The Marine Mammal Protection Act (MMPA) authorizes salmon growers to deter marine mammal predators from damaging cultured fish and gear. Until March 1995, the MMPA allowed growers to use lethal force to control the predators under certain conditions. The 1994 Amendments to the MMPA prohibit the use of lethal force. The NMFS established a seven member task force, the Gulf of Maine Aquaculture-Pinniped Interaction Task Force (MMPA Task Force), to investigate and report on the interaction of seals with aquaculture resources in the Gulf of Maine. In February 1996 the Task Force published their findings along with recommendations to mitigate the seal predation.

Discussion:

Based on observations of growers, it appears that seals generally attack cages from below. The Atlantic salmon respond by grouping tightly in one corner of the net. In some cases the seal is able to bite the fish and obtain portions through the net where in other cases the net itself is damaged leading to releases of pen-reared fish. Various attack strategies have been described ranging from a single seal and one time attack to repeated attacks to the same net site or different ones and attacks by groups of seals. Industry representatives who responded to a survey distributed by the MMPA Task Force indicated that attacks are most frequent in February and March, occur occasionally to frequently October through January and April through May, and infrequently during the summer.

The number of fish killed and/or released due to a seal attack varies significantly. In additional to direct kills, attacks can injure fish which then makes them more susceptible to disease. Diseased pen-reared fish pose a threat to wild populations, including wild Atlantic salmon. Injured fish, if detected early enough, can be isolated and treated with antibiotics. In addition, there is some speculation that a seal attack can lead to stress in a fish which can increase the potential for contracting a disease or ceasing feeding. It is very difficult to quantify the number of fish lost and/or released due to seal attacks. The MMPA Task Force acquired information from a New Brunswick insurance broker that attributes 50% of the claims submitted to predator losses and 30% of the dollar amount paid out to cover predation losses.

Conclusion:

Preventing or reducing the likelihood of pen-reared Atlantic salmon interacting with wild Atlantic salmon minimizes the potential for incidental take of wild Atlantic salmon. One way in which the aquaculture industry can minimize the potential for its industry to incidentally take Atlantic salmon populations proposed for listing is to reduce the potential for seals to release pen-reared fish from cages.

The MMPA Task Force examined a number of measures for deterring seals from cage sites including seal bombs and other legal underwater explosives, cracker shells, acoustic deterrence devices, predator vocalizations, predator models, predator introductions, aversion conditioning, translocation of depredating seal, human presence on the pen-site, patrolling and hazing by boat, dogs, non-penetrating projectiles, bubble curtains, siting of pens, husbandry, cage design and net tensioning, predator nets, perimeter nets, and biofouling of nets. The MMPA Task Force also examined lethal measures including culling of seals, on-site lethal taking and the option of designating an animal damage control team.

Recommendations of the MMPA Task Force focus on acquiring additional information on the factors that likely affect the vulnerability of sites to seal attacks including pen design, predator net designs, and siting as well as the effectiveness of proactive deterrence devices such as acoustics. The MMPA Task Force did not reach consensus on the issue of lethal removal of individual seals alleged to be the perpetrators of attack on pens. They did, however, agree on three criteria that would need to be met to justify an lethal taking. Those criteria are as follows: the consequences of the depredation must be severe and demonstrable; the lethal measures under consideration must be verified as an effective means of solving the predation problem, and no non-lethal alternatives are available. One of the reasons the MMPA Task Force and others are divided on the issue of lethal take is that there is a lack of information on the behavior of seal populations and individual seals in the vicinity of aquaculture sites.

Recommendation:

The Subgroup recommends that MDMR in cooperation with the aquaculture industry initiate research into the behavior of seal populations and individual seals in the vicinity of pen sites. In future years this study may require the ability to lethally take seals attacking sites to test the viability of this as a control measure. Consequently, the subgroup recommends that the state explore the possibility of securing authorization under the MMPA to conduct a study examining the efficacy of lethal take as a management tool to minimize losses of farmed salmon. The subgroup endorses the findings of the MMPA Task Force especially as they relate to improving our understanding of the effectiveness of deterrence devices and operational measures (ex: siting, mort removal, predator nets) to reduce the loss of farmed salmon attributable to seal attacks. If information does become available which proves the effectiveness of any one of these measures, the MDMR should work with the industry to ensure its application.

Atlantic Salmon Task Force
Aquaculture Working Group

Subgroup Report

Use of Sterile Fish in Maine Aquaculture

February, 1996

by

J.K. Bailey, Atlantic Salmon Federation (Lead Author)
C. Mantzaris, National Marine Fisheries Service
T. King, National Biological Service
H. Kerby, National Biological Service
E.T. Baum, Maine Atlantic Salmon Authority

Definition of Issue(s)

The only reason for using sterilized farmed fish would be to eliminate any possibility that escaped fish would spawn with wild stocks. Although it is not yet proven, there is a strong feeling that hybridization between wild and domestic salmon stocks may lead to a lessening of genetic fitness in the wild gene pools. Escaped, sterile salmon will still compete with wild stocks for food and habitat.

Background - History and description of current situation

Several methods of sterilization are possible. These include gonadal irradiation, hormone treatments, surgical sterilization and chromosomal (i.e. ploidy) manipulation. The use of irradiation and hormone treatments are not approved for food fish and surgical sterilization is not practical on the scale required. This leaves ploidy manipulation as the only reasonable approach for mass sterilization.

Triploid (3N) Atlantic salmon possess three sets of chromosomes in contrast to the normal (2N) diploid complement. Triploids can be produced either by mating tetraploids (4N) with diploids or by preventing the extrusion of the second polar body in diploid oocytes during meiosis. The protocol for producing tetraploid Atlantic salmon has not been developed and, at present, the only viable option is to prevent extrusion of the second polar body. This is be done by applying a chemical, temperature or pressure shock to fertilized gametes shortly after fertilization.

The chromosomal imbalance in triploid salmon leads to functional sterility. Triploid salmon do not produce viable offspring. It is the sterility of triploids that interests both managers of wild salmon stocks and the aquaculture industry. If all domestic salmon were sterile, cage escapees could not mate with wild salmon and the risk of altering native gene pools would be greatly reduced or eliminated. From an aquacultural production stand point, sterile fish would not become sexually mature and grilsing would be eliminated. This would be a win - win situation.

The impact of triploidy on gametogenesis is different for males and females. Triploid males experience near-normal testicular development and spermatogenesis. Testicular steroid hormone levels are similar to diploid males and secondary sex characteristics (kype formation, darkening, change in condition, etc.) also develop. While the sperm are non-functional, the sex drive appears to remain near-normal and they will mate with normal females. Because their gametes are not viable, triploid males are a genetic threat to wild populations. In females, ovarian development is severely retarded and secondary sex changes are not apparent. All-female populations are required to meet expectations.

All female populations can be produced by gynogenesis or by direct or indirect hormonal feminization. Gynogenesis uses irradiated, non-viable sperm to initiate embryonic development followed by chemical, pressure or temperature shocks to duplicate the maternal chromosomes. This technique has not been adapted by the aquaculture industry because it leads to rapid inbreeding accumulation. Direct hormonal application is not permitted for fish destined for human consumption.

Indirect feminization requires two generations. Fry from the first generation are fed a starter diet containing 17_-methyltestosterone for approximately 700 degree-days. This results in a population which is phenotypically "all-male". However, approximately fifty percent would have been females without the treatment and their genetic material remains female. At maturation, the genetic-female males (sex-reversed females) do not develop sperm ducts and can be separated from the true males. Surgical removal of the testes is necessary to release the spermatozoa.

Milt from sex-reversed females contains only "X" chromosomes. There are no "Y" chromosomes in sex-reversed milt. When this is combined with normal eggs, which also contain only "X" chromosomes, all resulting offspring will be "XX" or females. All-female triploids are produced by exposing normal eggs combined with sex-reversed milt to the triploid induction treatment. All protocols for these techniques have been developed and commercial production of all-female triploid salmon is feasible.

Analysis

The increased cost of triploidization must be offset by superior performance in order to compete, commercially, with diploid salmon. Although triploid salmon seem to grow somewhat faster under good conditions, there is overwhelming evidence suggesting that factors other than growth rate would make large scale farming of triploid salmon impractical. A review by Benfey (1991) outlines a number of physiological differences which may influence triploid performance in an aquaculture setting. Individual cells in triploid salmon are larger than those in diploids. Normal organ and body size are maintained by reducing the total number of cells present.

Although haematocrits (packed red cell volume) are similar for diploids and triploids, fewer, larger cells may affect performance. Blood haemoglobin and haemoglobin-oxygen loading ratios are lower in triploids. This means that their oxygen carrying capacity is reduced. Increased cardiac output is used to compensate for this inefficiency during periods of acute stress (King and Lee 1993).

Often, controlled studies with Atlantic and other salmonids have not given definitive results. Triploid and diploid survival was similar when the fish were exposed to acute periods of increased temperature (McCabe and Benfey 1995), hypoxia (Benfey and Sutterlin 1984) and handling (Biron and Benfey 1994). However, under chronic high temperature, triploid rainbow trout showed higher mortality rates (Ojolick et al. 1995). There are several reports that triploids do not survive well under sub-optimal conditions (Johnson et al. 1986, Quillet et al. 1987, Quillet and Gaignon 1990, Virtanen et al. 1990, Benfey 1991, Jungalwalla 1991, Ojolick et al. 1995). Benfey (1991) speculates that fewer, larger cells result in decreased cellular surface area to volume ratios. This would impair the fishes' ability to absorb and secrete molecules across cell membranes and may interfere with the normal function of some tissues and organs. Even behaviour (learning, response to light and sound, etc.) may be impacted because triploids possess fewer brain cells.

A large proportion (as high as 25% in some test populations) of triploid salmon are affected by lower jaw deformities in both Canada and Tasmania. There is speculation that this may be a manifestation of vitamin C deficiency (Hughes 1992) or be related to the growth rate of triploids (Lee and King 1994). Jaw deformities are not common in Scotland, where water temperature maxima are somewhat lower, offering additional support to the growth rate camp.

In a Norwegian study, all-female triploid salmon grew to weights in excess of 30 kg. before the experiment was terminated (H. Bentsen, pers. comm.). There was no indication of sexual maturation in the and no way to determine either life expectancy or the maximum size that the fish might attain. He suggested that escaped all-female triploids would probably live several years longer than diploid salmon and may reach weights in excess of 100 kg. Diploids, whether wild or escaped rarely grow to weights greater than six kg. and only live for one to three years in sea water.

Conclusions

Most studies conducted on triploids have been done in laboratories where environmental conditions are closely monitored. In a commercial operation, fish are grown at high densities and subjected to additional handling during grading, vaccinating, tank and cage cleaning, etc. If triploids are truly less fit and more fragile than diploids, under high or chronic stress conditions, performance differences may be even more amplified under commercial conditions.

Commercial assessment of triploid salmonids has been conducted in Scotland (Johnstone et al. 1991), Tasmania (Jungalwalla 1991), France (Boeuf et al. 1994), Canada (Piferrer et al. 1994, McGeachy 1995) and the USA (Galbreath et al. 1994). The initial opinions of farmers in Scotland, Tasmania and Canada are not encouraging. The fish simply are not performing. The marginally faster growth rates do not offset the initially higher costs, greater mortality, and increased down-grading due to deformities. The commercial use of triploid all-female salmon is not feasible at this time.

Recommendations

We recommend continued research in this area. All-female triploids are truly sterile and their use would eliminate any possibility of genetic interactions between wild and escaped domestic populations. Most of the technology has been successful, however there is still much to learn. Triploid fish grow as fast or faster than their diploid counterparts. If the mortality and deformity problems can be minimized triploids would be very attractive for commercial production.

A large scale triploidy study, involving a number of European countries has recently begun. Commercial scale rearing is planned at a number of locations. Close monitoring of the results in this study may provide additional insight.

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TABLE 1. Potential Risks to River Specific Atlantic Salmon Related to Aquaculture Reared Salmon & Recommended Actions to Reduce Threats

This table is currently not available.

I. Forestry

The Governor's Atlantic Salmon Task Force developed this report as part of the State of Maine's Conservation Plan for Atlantic salmon in the Sheepscot, Ducktrap, Narraguagus, Pleasant, Machias, East Machias, and Dennys Rivers. This report underscores the all-important blend of regulatory actions and volunteer efforts in the protection of Atlantic salmon and water quality. The Task Force intends for all recommendations to further a relationship of collaboration and cooperation among resource users in the seven river watersheds.

This report presents an overview of forestry activities in the seven river watersheds followed by a discussion outlining the rationale for actions to reduce threats to Atlantic salmon from forestry related activities and promote salmon recovery. Next, each threat is covered presenting the latest thinking on its risk to Atlantic salmon and habitat. Table A lists (1) potential risks to Atlantic salmon habitat from forest management activities, (2) management changes or activities proposed to reduce the threat and promote the recovery of salmon populations, (3) responsible entity, (4) costs, (5) implementation date, (6) rationale, and (7) range of alternatives not selected. Appendix 1 presents Maine's Conservation Plan for Atlantic salmon populations in a format suggested by the National Marine Fisheries Service to be used when applying for a general permit for incidental take of a listed species. Appendix 1 addresses each requirement of the law in the *a-e* outline format for each potential threat that could result in incidental take from forest management activities. Appendix 2 is background material on the statutes, rules, and programs in Maine covering forestry and water quality. Appendix 3 details the various voluntary initiatives devoted to Atlantic salmon recovery in the seven river watersheds. Appendix 4 presents information on historic use of forestry related pesticides. Appendix 5 lists the standards used by regulatory agencies to protect water quality from land use activities. And finally, Appendix 6 is a table showing the estimated costs of completing habitat mapping and assessment work on the seven Atlantic salmon rivers.

1. Introduction / Overview

The U.S. Fish and Wildlife Service and the National Marine Fisheries Service concluded in their report, *Status Review for Anadromous Atlantic Salmon in the United States* (January 1995) and in the Federal Register (29 September 1995), "while historic forest practices have had harmful effects on Atlantic salmon in certain watersheds, many state and federal laws now exist to prevent or significantly reduce adverse impacts to Atlantic salmon and other aquatic species. Current forest practices are not considered a major threat to Atlantic salmon" (Dept. of Interior, 1995). The Services acknowledge that forest practices will play a small part in the State of Maine's Atlantic salmon conservation efforts. The Plan's strategies addressing forest practices in concert with other proposed measures represent the best opportunity for the eventual recovery of the Atlantic salmon in the seven Maine rivers.

Description of Forestry

Forestry is the dominant land use in the five downeast river watersheds. By comparison, the Sheepscot and, to a lesser extent, the Ducktrap river watersheds experience limited forestry activity. Forests in the seven river watersheds consist of softwood, mixed softwood, and hardwood stands. Like all the forests in Maine, these areas have been providing wood products for over 200 years. Some stands are on their 4th cycle of cutting and regeneration. Years ago, loggers exclusively harvested trees for its lumber. Today, however, besides lumber, the forest provides material for pulp and paper manufacturing, biomass energy plants, and many wood specialty mills.

Economically, forest resources have supplied a continuous stream of raw materials for lumber and pulp and paper production, providing a stable economic base throughout Maine's history. Today, this primary production remains a bulwark of the state's economy, approximately 18% of the gross state product. Biologically, the forests provide genetic and ecosystem diversity, natural systems for counteracting air and water pollution, innumerable animal and plant habitats, and many other values.

Timber cruising, resource evaluation, stand improvement, road construction and maintenance, and harvesting are all activities commonly associated with forest management. More than 95% of the forests are regenerated using techniques that culture natural regeneration of native species. Today, foresters use pesticides sparingly (see Appendix 4) and rarely fertilize timberlands. Large landowners may harvest trees once every 40-50 years depending on tree growth rates or they may selectively cut a stand more frequently. During the spruce budworm infestation from the early 1970s to the mid 1980s, landowners increased harvesting dramatically to salvage valuable, dying spruce and balsam fir. Forestry activities by their nature are ubiquitous within the seven river watersheds. Harvesting involves getting to and cutting timber by means of machinery designed to move around in difficult terrain. Getting timber and hauling it out of the woods can lead to soil disturbance which can initiate sedimentation events. Careful forest practices can reduce these impacts but not eliminate them entirely.

Champion International Corporation is the largest landowner within the five Downeast river watersheds owning approximately 342,000 acres. Their largest holdings are in the Narraguagus, Machias, East Machias and Dennys rivers' watersheds. Georgia Pacific Corporation is a major landowner in the Dennys and East Machias rivers' watersheds. Each manages its forest resources primarily for the harvesting and production of pulp for paper manufacturing. Their two principal land use activities are timber harvesting and road building. Smaller wood lot owners also harvest timber within the Sheepscot and Ducktrap river watersheds. Harvesting can take place any time of the year throughout each watershed. Often land managers prefer winter harvesting to reduce harvesting impacts. Typically road building occurs during the warmer, dryer months.

The map on the following page shows each of the seven Atlantic salmon river watersheds covered in this report and two graphs germane to forestry. The first graph illustrates timber harvesting in each watershed over five years (1990-1994) as a percentage of the total watershed area. The comparatively low percentage for the Dennys River watershed is because in the 1980s Georgia Pacific extensively cut, primarily, for budworm salvage. Those areas are currently regenerating. The second table shows harvesting data for each watershed over the same five year period by the number of acres cut. These tables provide a general glimpse of recent harvesting activity in the seven river watersheds.

2. Actions to Reduce Threats and Promote Recovery of Atlantic salmon

A. Narrative supporting rationale for actions

Through Maine law and voluntary initiatives, landowners, private groups and government agencies have applied many measures to limit impacts of forestry activities on water quality. Regulations governing cutting in shoreland areas, road construction, erosion control, and drifting pesticides exist and are the clear responsibility of forest managers and forest landowners. In the creation of Maine=s water quality protection laws, Maine lawmakers developed water quality standards to safeguard all aquatic organisms including Atlantic salmon. . In addition, the Natural Resources Protection Act which governs activities in and around rivers and streams specifically reference Atlantic salmon and its significant habitat as areas for protection in the permit process. The Land Use Regulation Commission's standards (see Appendix 2) allow the Commission to zone significant fish habitat. To properly utilize these additional regulatory tools, state agencies must identify and map significant habitat and develop standards to protect these special zones through formal rule-making procedures. To date, there has been no identified need or concern to initiate use of this additional regulatory protection due to the stringency of other controlling standards. The newly created maps of critical salmon habitat in the seven downeast rivers are an opportunity to review whether uniform statewide water quality protection standards are adequate to protect these areas. Additionally, the maps provide an opportunity for state agencies to develop cooperative agreements with landowners to protect these habitats, and decide whether any new zoning standards are necessary in the absence of landowner agreements.

For years the State of Maine has recognized the need to work with forestry professionals to help contain the effects from road building, logging, and silviculture operations. Landowners and agencies have developed improved management practices and protective standards in response to concerns that forestry activities may be contributing to non point source pollution. Compliance with comprehensive, existing regulatory mechanisms coupled with focussed volunteer efforts (see Appendices 2&3) are ongoing safeguards against threats to individual Atlantic salmon and their habitat. Continued vigilance by landowners, regulatory agencies and volunteers will mean incidental take of salmon remains unlikely.

There is little evidence to suggest current forest practices around the seven rivers have contributed to an incidental "take" of Atlantic salmon. Studies in eastern Canada link land management practices to changes in Atlantic salmon and macroinvertebrates, raising concerns about water quality and habitat degradation if forest managers and contractors do not closely follow best management practices, buffer strips, and water quality regulations. Closer to home, a 1995 study of macroinvertebrates on the Narraguagus found that neither water quality nor the food base for juvenile Atlantic salmon has deteriorated between 1974 and 1992 (Siebenmann 1995).

Researchers stress the critical importance of well vegetated, riparian buffer strips along streams to reduce forestry impacts on water quality and fish habitat. This report bases its recommended actions upon the growing recognition within the scientific community that separating intensive land use activities from complex natural systems are necessary to sustain larger forest ecosystems and maintain water quality.

1) Assess Forest Cover / Hydrology Dynamics in Watersheds

Specific Actions:

a) Forest Service and landowners will cooperatively assess the potential for abnormal flow in the watersheds using remote sensing and model hydrology dynamics and present findings to local watershed councils.

Are abnormal stream flows as influenced by forest practices a problem for Atlantic salmon in any of the seven river watersheds? On a large watershed scale, we believe they are not. Watershed dynamics research from the past several decades indicates that water yield increases begin when harvested sites are subject to removal of more than 25% of preharvest basal area (Hornbeck et al. 1993). The same research indicates that such sites regain their preharvest interception and transpirational functions within 3 to 10 years of harvest (depending on forest type, etc.) Watershed flow dynamics can be modeled for effect with the two variables of how much area has been harvested with a greater than 25% removal, and the time frame of these harvest operations. Existing data from the seven Atlantic salmon river watersheds from 1990 -1994 show a range of harvesting from 11% of the Narraguagus River watershed to slightly greater than 2% of the Dennys (see graph 1 on map). During salvage operations following the last spruce budworm infestation (1972-1984), landowners cut greater percentages of the downeast river watersheds. These salvage harvests are now 10 to 25 years old, beyond the maximum time of hydrological impacts. The overall reduced pace of harvest operations combined with the recovery period of watershed dynamics strongly suggests that watershed dynamics are not significantly altering stream flow in the seven river watersheds. To ensure that the future pace of timber harvest does not change this status, it is proposed that analysis incorporating more detailed harvest area data with computer models predicting stream flows be utilized to refine our knowledge of this issue.

Potential impacts on local, sub-watersheds from abrupt and gradual changes in forest cover may affect water yield to small streams with high Atlantic salmon habitat value. Moreover, local stream flow increases associated with a reduction in basal area may be particularly significant to an individual prime spawning area but relatively insignificant in the entire watershed. Information about the importance of possible elevated stream flows both at specific sites and the entire watershed will be important for habitat protection efforts. Using proven hydrologic models and existing data from the USDA Forest Service decennial Forest Inventory and Assessment, the Maine Forest Service and landowners will analyze new information to predict the potential for abnormal stream flows from reduced basal area in a watershed or sub-watershed. Such analysis will be made part of the full review and analysis conducted by both the Maine Forest Service and USDA Forest Service.

Models simulating forest and hydrologic conditions provide reliable water yield and stream flow analysis. Individual stream gauging is the most accurate technique for measuring harvesting effects but is too costly and unnecessary. The use of hydrologic models has proven to be accurate based on comparisons with stream gauging data at Hubbard Brook. Stream gauge data alone does not help define acceptable harvesting thresholds which models can do. Another strength is to predict results of harvesting on stream flow prior to cutting. Armed with this information, forest managers will balance their harvesting decisions with the needs of Atlantic salmon habitat. Local watershed councils will use the new information to work with landowners to reduce the threat of increased stream flow to the Atlantic salmon's most important spawning and rearing areas.

2) Complete Habitat Mapping and Assessment -

Work with Landowners,

Zone Resource Protection or

Fish & Wildlife Protection District

Specific Actions:

a. The Atlantic Salmon Authority will complete its habitat mapping and assessment work.

b. The Atlantic Salmon Authority and the Maine Department of Inland Fisheries and Wildlife will cooperatively work with landowners to develop cooperative Memoranda of Agreement (MOA) for the protection of all important Atlantic salmon habitat.

c. In the absence of comprehensive landowner MOAs, the Atlantic Salmon Authority will petition regulatory agencies to zone "Significant Atlantic salmon Habitat"with standards.

d. DEP, working with landowners and others, will direct their efforts with municipalities to strongly encourage towns to place Significant Atlantic salmon Habitat in Resource Protection zones.

e. LURC, working with landowners and others, will incorporate Atlantic salmon habitat mapping by rezoning these areas to Fish and Wildlife Protection Subdistricts as the information becomes available in the absence of landowner agreements. The Commission will also need to work with the Atlantic Salmon Authority to develop standards for activities in the new protection subdistricts.

Any open water that provides either food or refuge to Atlantic salmon in the seven rivers is considered habitat that forestry activities could potentially affect. The Atlantic Salmon Authority has been identifying Atlantic salmon habitat that is critical to the survival of the populations in the seven rivers. Salmon use other parts of the rivers and streams, but the "Significant Atlantic salmon Habitat" is paramount to the fish's survival. Current regulations provide adequate, general protection of water quality from forestry activities but may not specifically protect the Atlantic salmon's most sensitive and important habitat.

Classes of significant Atlantic salmon habitat revolve around its various life stages. Atlantic salmon habitat is typically designated as either spawning, nursery (juvenile rearing), or adult holding areas based on characteristics such as water depth, velocity, temperature, and bottom substrate composition. For example, spawning areas and deep pools that provide protection to adults and juveniles are critically important areas and vulnerable to change. Cool water refugia (spring seeps and deep pools) are also very important habitat as they provide cool water during the summer months. Riffles and rapids are essential for juvenile growth and survival. Spawning habitat is also the most vulnerable to siltation or other disturbances. It also comprises a relative small portion of each drainage. For example, the Atlantic Salmon Authority (hereafter, the "Authority") has learned that only 5% of the Narraguagus River salmon habitat is suitable for spawning. This figure is similar to that noted for other salmon rivers.

Ongoing habitat assessment and mapping work by the Authority presents an excellent opportunity to use specific information to focus protection on the salmon's most important habitat (see Appendix 3 & 6). By working with landowners, resource agencies can alert forest managers about the existence of prime salmon habitat. Cooperative agreements between the Authority / IF&W and landowners regarding forest management activities adjacent to important habitat will help to ensure the integrity of these areas. Conservation easements and land acquisition are other tools landowners, state agencies, and private conservation groups can use to protect salmon habitat.

Nearly a decade ago, Maine lawmakers enabled the Authority, as well as the DIF&W to define Atlantic salmon habitat as "significant wildlife habitat" under the Natural Resources Protection Act (NRPA). Such a designation allows DEP and municipalities to apply appropriate regulatory standards, through Shoreland Zoning and stream alterations under NRPA, to activities in and around important geographic areas. Similarly, the Land Use Regulation Commission can further protect "significant fish spawning, nursery, and feeding areas" through the application of its Fish & Wildlife Protection subdistrict standards if presented with information identifying the need (see Appendix 2). To properly utilize these additional regulatory tools requires that state agencies, through formal rule making procedures, identify and map significant Atlantic salmon habitat with supporting evidence. It remains to be determined whether existing statewide water quality protection standards are adequate for protecting the significant habitat, or whether new standards under these additional zoning powers are necessary.

The Authority anticipates completing the mapping and assessment work in early 1997. Until the Authority makes this information available to municipalities and state regulatory agencies, land use activities (not exclusive to forestry) may compromise the integrity of prime Atlantic salmon habitat. By contrast, once the Authority maps the information, landowners can prevent most activities from directly (and sometimes indirectly) affecting Atlantic salmon habitat. For example, if a road builder needs to cross a stream containing important salmon habitat, he/she can change the crossing location to reduce risks to the habitat. Additionally, state agencies can direct foresters working upstream of prime habitat to control sedimentation or pesticide drift.

DEP, LURC, and municipalities each have the mechanism in place to immediately (or nearly) use significant Atlantic salmon habitat information for the salmon's long term protection. Regulatory organizations will continue to rely upon Authority biologists for advice on individual projects with the potential to affect salmon habitat. Declaring the entire freshwater range of the Atlantic salmon as "significant wildlife habitat" is impracticable, inefficient, and outside the bounds of Maine law. Conversely, ignoring new information as it becomes available discounts the use of an intended regulatory tool and proven agreements between landowners and the Department of Inland Fisheries and Wildlife.

3) Promote Voluntary Management of Road Impacts and Enforce Existing Regulations

Specific Actions:

a) Working with landowners, resource managers, and appropriate state agencies, the Maine Forest Service will revise and update best management practices and regulatory agencies will increase enforcement and compliance monitoring for activities in shoreland areas.

b) State agencies will work with Project SHARE to design and implement an ongoing program to educate road building and logging contractors and landowners on the importance of Atlantic salmon habitat and to promote the use of forestry best management practices.

c) Landowners working through the "Sustainable Forest Initiative" (SFI) program (see

Appendix 3.) of forestry and conservation practices will provide education material and promote the use of road construction best management practices in Atlantic salmon river watersheds.

d) Resource agencies working with Project SHARE, landowners, and others will cooperatively monitor key access points and control access where necessary and appropriate.

It is forest roads that have been the largest source of forestry non-point sedimentation in the past.Today, the combination of required road building and harvesting standards (see Appendix 5) and forestry best management practices provide a sound foundation for managing effects from road maintenance and building activities and skid trails. These requirements and voluntary measures have reduced soil erosion and sedimentation of the seven Atlantic salmon waterways to a level where continuous monitoring and measurement of current amounts would be prohibitively expensive. Moreover, land managers and resource agency personnel have all observed the substantial improvement in forest management road quality through the use of new construction techniques.

DEP, the Maine Forest Service (MFS), and the University of Maine have been conducting a thorough evaluation of the effectiveness of forestry best management practices. The assessment includes a field evaluation by statistically sampling 120 harvested sites, identified through MFS timber harvesting notifications. A soil scientist evaluated the sites using a BMP check list to determine how the measures are performing. An initial review of the field data indicates that most forestry best management practices are very effective when applied, but an opportunity to increase compliance exists, especially on the smaller operations. For example, certain best management practices associated with haul roads, stream crossings, skid trails, post harvesting site preparation, yards and landings, and streamside management showed a significant number of sites where compliance was relatively poor and sedimentation into water bodies had occurred. A more detailed interpretation of the data will likely reveal the need for some changes to forestry best management practices, and what type of operations warrant a new education effort. The field data are reported in the Cooperative Forestry Research Unit Bulletin #11 by Briggs, et.al.

Like many of the best management practices, Maine's regulations (see Appendix 2) are designed to prevent non point source pollution. Specifically, erosion , sedimentation, shade removal, obstructions in streams, and the introduction of chemicals into streams are all addressed in current statutes or administrative rules. While current regulations do not prevent forestry activities from degrading Atlantic salmon habitat, they provide a strong foundation for the additional best management practices. Furthermore, volunteers working on specific enhancement projects (see Appendix 3) are an important partner in compliance monitoring.

Local compliance and individual initiative are the cornerstones of keeping the salmon waterways free of non point source pollution. Project SHARE (see Appendix 3) is an important bridge between regulation and applied field practices. As an organization, Project SHARE can offer an education program, eliciting cooperation from road building and harvesting contractors on regulation compliance and BMP use.

Land management roads are increasingly used for access to rivers and streams. On the five Downeast rivers, Project SHARE can initiate work with landowners, river groups, angling clubs, and state agencies to manage existing and future access points to the rivers. Together, state agencies and private groups can manage key access points with an eye toward protecting Atlantic salmon's most important habitat. Their efforts must support responsible legal angling and eliminate illegal fishing. All stakeholders need to recognize their responsibility in managing key access points to protect important habitat. Local suggestions concerning limiting access stand the best chance of gaining acceptance from anglers. Project SHARE's broad membership presents an opportunity to promote ideas of access management to local angling and river groups.

4) Support Current Riparian Harvesting Restrictions / Enhance Headwater Protection

Specific Actions:

a) Increased enforcement and compliance monitoring for shoreland timber harvesting by regulatory agencies

b) Project SHARE will educate logging contractors and resource managers to be sensitive to shading needs when planning tree harvesting in shoreland areas.

c) Landowners working through the "Sustainable Forest Initiative" (SFI) program of forestry and conservation practices will provide education material and promote the use of streamside best management practices in Atlantic salmon river watersheds.

Water temperature increases may affect Atlantic salmon feeding and spawning habits and significantly impede the upstream migration of adult Atlantic salmon (Moring & Finlayson 1996). Studies have shown that stream canopy removal increases solar radiation on a stream and can raise water temperatures significantly. Also, increased temperatures and direct sunlight may contribute to algal blooms which shrink available salmon habitat.

The combination of LURC=s standards & DEP=s Natural Resources Protection Act standards requires that all streams with a mineralized bed be protected from logging disturbance and sedimentation. The extent of the protective standards varies by stream size and watershed area, with the most common threshold between streams that are on USGS maps, and streams too small to be identified on maps. Current regulations in Maine minimally require that loggers, over a ten year period, remove no more than 40% of a stand within 75' of all USGS mapped streams. Unmapped streams are protected by water quality performance standards rather than by riparian harvesting standards. As an example, in the unorganized territories, the 40% rule does not apply to streams that are upstream from the point where the drainage is 300 acres or less (under LURC's shoreland/timber harvesting standards). Also, LURC standards require loggers to maintain shading in shoreland areas between the 300 acre drainage point and the 50 square mile drainage point. The difference is that under DEP's rules a certain amount of tree canopy must be left intact, whereas, under LURC standards, the shading does not necessarily have to come from windfirm trees. It is far easier to enforce standards that apply to harvesting in riparian areas than the water quality performance standards of the smallest and unmapped streams. This has raised the question of the status of protection and health of the unmapped stream segments of a watershed. There is no definitive assessment on this issue at this time.

Strict compliance with NRPA, Shoreland Zoning rules, and LURC timber harvesting standards is the best means of maintaining stream temperatures and protecting salmon habitat in most watershed areas. DEP, municipalities, and LURC are responsible for enforcing timber harvesting regulations in shoreland zones. Continued vigilance by local code enforcement officers and DEP and LURC enforcement staff will help maintain an adequate stream canopy.

Regulations alone cannot address specific site conditions. Forest managers can make field decisions that benefit salmon habitat if they are aware of the interrelationship between stream temperature and overstory. For example, a tree providing mid-day and afternoon shade is more valuable than one casting a shadow on a stream during the morning hours only. Moreover, education will motivate landowners to make site specific decisions that achieve the best protection of salmon habitat.

5) Enhance Atlantic salmon habitat

Specific Actions:

a) Support Project SHARE, Ducktrap River Coalition, and the Sheepscot Valley Conservation Association and local river groups to remove blockages including beaver dams with advice from fisheries biologists

Not all woody debris is detrimental to salmon habitat. Some blow-downs and trapped logs help create protective holding pools for Atlantic salmon, particularly juvenile salmonids. Other debris provides an energy source in the form of organic carbon for a variety of aquatic animals (Bilby & Likens 1980). Project SHARE has begun a program of removing key blockages on certain tributaries of the Machias River. A systematic approach designed by fish biologists for removing non-beneficial logs and slash on all the Atlantic salmon rivers and streams will increase available spawning and nursery habitat. Further gains in maintaining and enhancing habitat may be achieved by breaching beaver dams and / or removing beaver from selected moderate to high value tributaries. Potentially, this work will allow greater fish passage, increase stream flow, and help maintain dissolved oxygen. With the high populations of beaver, it will be critical to time the breaching of dams with salmon needs or to provide ongoing maintenance.

6) Comprehensive Management of Forest Chemicals

Specific Actions:

a) DEP, ASA, & BPC will review the geographic usage of pesticides in the seven watersheds and DEP will target areas for in-stream assessment.

b) The Board of Pesticide Control will work cooperatively with state agencies and the University of Maine Co-operative Extension Service to update best management practices based on the latest research and promote the use of these practices within the seven river watersheds.

c) The Board of Pesticide Control will respond to evidence of pesticides causing adverse environmental effects by proposing amendments to its regulations, updating best management practices, and changing product registration.

Presently, the state does not have the means nor the process to find out all the chemical products industry and homeowners are using in a given watershed, whether they are getting into streams, and whether they are at levels to cause habitat modification or fish mortality.

The forestry industry supports taking precautions to prevent water quality degradation from pesticide use, habitat modification, or acute and chronic effects on Atlantic Salmon. The industry's goal is to use available technology to maintain or increase total production while protecting the rivers' natural systems. Land managers use pesticides on forests in the watersheds of the seven rivers ranging from low to high toxicity. Currently, there is no scientific evidence to suggest that their proper use poses high risks to the Atlantic salmon.

Although there are no indications of imminent risk today, new product research and watershed specific information may reveal the need for future precautions. Since uncertainty exists concerning adverse impacts to Atlantic salmon or its habitat from pesticide use, there will be a need to keep abreast of the latest toxilogical data on forest pesticides. The Board and DEP, with the help of an environmental toxicologist, will review pesticide toxicity data. A flow of new, usable information will allow the Board and the Maine Cooperative Extension Service, in consultation with pesticide users and state agencies, to periodically update best management practices and regulations, as appropriate, to safeguard Atlantic salmon and its habitat.

B. Threats to salmon habitat

Assessing the magnitude of incidental take in the seven rivers from forestry activities is a speculative exercise. Current research does not identify specific habitat degradation resulting from forestry activities in any one of the seven rivers. Information on forestry related impacts to Atlantic salmon habitat comes from research on fisheries and non-point source pollution. We know that any of the following threats can cause habitat loss. There are no indications that threats from forestry operations are causing a significant adverse impact to Atlantic salmon and its habitat. Given the low numbers of fish in the seven rivers, our strategy is to reduce the risks to Atlantic salmon to the greatest extent possible.

{F-1} % of watershed in a regenerating forest condition affects water flow dynamics that may alter available habitat

- Precipitation, transportation, evaporation, and transpiration all influence a watershed's hydrologic cycle. Changes to one part of the cycle often have consequences for another part. Tree canopies and understory plants play an essential role distributing water throughout the hydrologic cycle. Soils in an undisturbed forest absorb water while trees and plants intercept and evapotranspire a significant portion of precipitation in a watershed (10-20% of total rainfall) (Leonard 1961). We know that tree harvesting on a large, intensive scale may temporarily increase stream flows.

- While precipitation in Maine is relatively uniform over 12 months of the year, stream flow is not, in part, due to the presence of forest cover. Hydrologists calculate that two-thirds of the average precipitation in a northern hardwood forest becomes stream flow (Hornbeck and Leak. 1991). From December to March snowpack banks stream flow water. In the spring, a large amount of water enters streams as the snowpack melts. Vegetation can moderate stream flow by both holding snow on the ground longer and transpiring some of the water absorbed by the soil. Simply put, an area dominated by forest cover is better able to intercept and retain precipitation than an area with little ground cover.

Much of our knowledge about forest to stream hydrology comes from years of data collection and interpretation within eight small watersheds at the Hubbard Brook Experimental Forest in central New Hampshire. Although the forests at Hubbard Brook are predominately hardwood, there are enough similarities with mid-coast and downeast watersheds to draw meaningful parallels. For example, a thick organic layer on top of coarse-textured mineral deposits makes up typical soil horizons in Northern New England forests. These conditions are ideal for water infiltration and movement of water to streams.

- {F-2} Land managers and developers may unwittingly disturb important Atlantic salmon habitat through various land use activities including forest practices.

- Anglers and fishery biologists probably know where the important Atlantic salmon habitat is on the seven rivers, but most regulators and forest managers may not. A municipality or a state agency may allow an activity in or next to a stream site where Atlantic salmon spawn, irrevocably damaging the spawning beds. A timber company may design a logging road to cross a stream at a location which contains important riffles for juvenile salmon. Moreover, there may be an appropriate distance from the riffles either upstream or downstream, that would allow the crossing and the habitat to coexist. Neither the permitting agency nor the forester has advance knowledge about the location of important habitat or standards of performance working near prime habitat.

Losses of Atlantic salmon habitat are avoidable using the best available information. Much of this information has been (and is being) collected by the Atlantic Salmon Authority and the U.S. Fish & Wildlife Service (see Appendix 3 & 6).

- {F-3} Skid trails, road construction, maintenance, & placement may cause secondary impacts that affect salmon such as: ❶ sedimentation that may clog spawning beds & hinder alevin emergence; ❷ poor culvert installation that blocks fish passage; and ❸ increased access that may create greater fishing pressure

- Soil disturbance from logging operations and road construction may contribute to higher than normal sediment loads in streams and rivers. Not all road building and harvesting operations result in stream sedimentation especially when contractors and loggers closely follow best management practices (Martin & Hornbeck, 1994). In areas where excess sediments do enter streams or rivers, researchers have found suspended solids settling in gravel areas typical of fish spawning beds. Fishery biologists are concerned that reducing gravel bed permeability may discourage spawning activity and / or may increase mortality of emerging fry. The identification and mapping of these critical areas will allow for more targeted assessment of risk from sedimentation.

- Several studies show that Atlantic salmon mortality is high during hatching and fry emergence under undisturbed, normal conditions (Gustafson-Marjanen & Moring, 1982, Pauwels & Haines 1994, MacKenzie & Moring, 1988). Direct evidence from research from New England salmon rivers confirms high mortality rates during the salmon's alevin intragravel stage. Boosting levels of sediments during a vulnerable life stage of Atlantic salmon may further increase mortality rates by trapping and/or suffocating alevins so they cannot leave that environment (Moring and Finlayson, 1996). Fish biologists do not currently know the extent of alevin mortality associated with sedimentation in the seven Atlantic salmon rivers. Studies are needed to determine this accurately.

Despite the lack of site specific information on forestry practices effects on water quality in the northeast (Stafford et al, 1995), we can piece together salient conclusions from the literature on forestry related non-point source pollution. The well-known Hubbard Brook experiments revealed that tree cutting is not the primary cause of soil erosion in a woodlot. Other studies overwhelmingly point to haul roads and skids trails as principal sources of erosion (Martin & Hornbeck, 1994), especially where roads and harvesting operations intersect with flowing waters. Another study conducted by Garman and Moring in 1991, showed a marked increase in suspended solids following a clearcut without buffers strips along the banks of the East Branch of the Penobscot River. Still, other research has documented the effectiveness of buffer strips in controlling erosion and sedimentation. Despite the erosion's origin, sediment in salmon streams and rivers results in habitat loss by clogging stream bed gravel, compromising embryo survival and eliminating spawning areas (MacDonald et al. 1991). Another consequence of sedimentation is a decrease in macroinvertebrate density in streams due to burying of their habitat (Taylor 1989). Reduced food sources for salmon may lead to poorer growth and condition.

Impoundments and dams limit an Atlantic salmon's freshwater range. Similarly, poorly placed or undersized culverts (usually from road building and maintenance) can also hinder fish passage, effectively reducing access to potential habitat. Unhindered upstream and downstream migration is critically important for salmon. Impediments, large or small, can have a negative effects. Fish biologists do not know the extent of impacts on salmon populations from improper culvert placement in the seven river watersheds. BMPs require specific culvert placement to avoid fish passage problems.

Forest management roads have contributed to recreational access throughout the state. A strong tradition of public access to private land and landowner benevolence has broadened the use of roads whose primary purpose is to move fiber. In turn, access to various streams and points on the 5 Downeast rivers and to a lesser extent on the Sheepscot and Ducktrap Rivers has allowed increased angler use. Data do not exist on the consequences of road construction near salmon rivers and streams. Without doubt, improved access over paper company roads has accelerated declines in angling quality for wild brook trout in the five downeast rivers and numerous tributaries. Improved access may have also contributed to increased mortalities of juvenile salmon which are caught incidentally by trout anglers.

- {F-4} Excessive woody debris blocking fish passage, restricting stream flow, and reducing dissolved oxygen

- Woody debris can enter streams in a variety of ways. During road construction and harvesting, loggers may accidentally (or otherwise) discard logs and slash in riparian areas, near enough to enter a stream. Natural mortality of streanside trees and undercutting of stream banks also add debris. Too much debris in a stream can alter habitat by inhibiting fish migration, limiting stream flow, or reducing dissolved oxygen (Moring et al, 1994). Organic carbon is an important energy source for aquatic animals. Beaver dams can have the same harmful effects on certain tributaries. Studies have shown when people or flooding removes debris dams, aquatic systems loose organic carbon (Bilby & Likens, 1980). Thus, a balance of the right type and amount of woody debris is necessary to maintain salmon habitat.

- {F-5} Increased temperatures and algal blooms from excessive shade removal along streams can adversely affect Atlantic salmon survival by changing their feeding, reproductive, and migratory behavior, reducing suitable rearing habitat and available cold water refugia, and eliminating macroinvertebrate habitat.

- Fish biologists have observed variations in water temperature affecting Atlantic salmon feeding and spawning behavior. For example, laboratory experiments have shown that juvenile Atlantic salmon feed only within a specific temperature range (Elliot 1991). Higher temperatures have prompted adult Atlantic salmon to slow upstream migration (Shepard, 1995) and can result in egg mortality as temperatures reach 12°C. Successful egg fertilization is also temperature dependent with Atlantic salmon preferring 6°C (Danie et al, 1984). Biologists believe juvenile Atlantic salmon can tolerate higher temperatures than adults. Temperature also influences the timing of incubating and emerging salmon. Studies of coho salmon have revealed that fry emerge in warmer waters prematurely, placing them in streams at times of limited food supply (Scrivener & Anderson, 1984). Scientists have linked thermal increases to the delay of smolts' downstream passages raising concerns that the migrating juveniles arrive at lower rivers locations where dissolved oxygen is low (Cave, 1985) and disease more prevalent (Buchanan et al, 1983).

Harvesting activities which remove significant riparian shade will raise water temperatures. Solar radiation increases when a stream canopy is opened. Salvage harvesting along streams in Maine in the 1980s allowed scientists to record temperature differences and rates of temperature increases from before and after canopy removal. The results clearly show the moderating influence of shade on stream temperatures over an entire spring, summer, and fall. Long term studies in other parts of the country show significant elevated stream temperatures after removal of riparian vegetation (Moring & Finlayson, 1996). Further, researchers have documented decreases in salmonid biomass in stream areas with unobstructed sun (Platts & Nelson, 1989).

As water temperatures rise, dissolved oxygen levels decline. Fishery biologists have linked reduced dissolved oxygen to poorer salmon growth (Elson 1975; Kazokov & Khalyapina 1981) and even increased mortality (Graynoth, 1979). Low dissolved oxygen levels are especially problematic for incubating eggs and alevin residence (Moring & Finlayson, 1996). Without additional research the direct links between Atlantic salmon mortality and dissolved oxygen depletion will remain unknown.

Clearing riparian vegetation at levels that cause abnormal temperature increases can greatly affect salmon. No evidence exists that timber harvesting activities in the seven river watersheds is currently elevating water temperatures. Regardless, it is prudent to be sure that small headwater streams are adequately protected to help maintain cool water temperatures for Atlantic salmon. Current regulations, where they apply, appear to adequately maintain shading on second and third order streams.

New policy initiatives, such as those proposed in the Compact for Maine's Forests, will identify practical steps to further protect cold water fisheries (117th Maine Legislature, 1996). Meanwhile, voluntary measures such as best management practices and Champion's riparian harvesting policies (see Appendix B.) will continue to augment regulatory shading requirements.

- {F-6} Direct and indirect sublethal effects to salmon from improper use of chemical pesticides and use of pesticides that are toxic to aquatic organisms.

- Research on the effects of certain chemicals on fish shows a range of toxicity of forestry pesticides (see Appendix 4) from non-toxic to extremely toxic. While dated, the definitive 1991 study by Norris, Lorz, and Gregory concludes that there can be both direct and indirect effects on salmonids from exposure to forest chemicals. Furthermore, direct application of pesticides to a water body significantly increases the risks to salmon populations (Norris et al, 1991). Fortunately, current regulations control the drift of chemicals into streams and rivers by imposing weather condition criteria and spray technology requirements. Indirect effects of chemicals can alter the density and community organization of aquatic and terrestrial plants and insects. Fishery biologists do not fully understand these indirect effects. Today, forestry pesticide use in the seven river watersheds is site specific and not widespread. Foresters anticipate insect infestations such as the spruce budworm to reemerge, requiring more extensive use of both biological and to a lesser extent, chemical controls.

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Table A. Potential Risks to Atlantic salmon habitat related to Forest Management.

Potential Risk to Atlantic Salmon Habitat from Threat	Managment Changes and Activities Porposed to Reduce Threat and Promote Recovery	Potential of Activity to Reduce Threats	Feasibility of Accomplishing Activity	Responsible Entity(s)	Implementation Date	Cost *=existing funds	Discussion/Rationale
{F-1} % of watershed in a regenerating forest condition effects water flow dynamics that may alter available habitat	Assess the potential for abnormal flow in the watersheds using remote sensing and model hydrology dynamics and present finding to local watershed councils	Low	High	Maine Forest Service / Landowners	1998, 1999	$20,000	Forest regeneration conditions within each watershed are likely to be different. Specific watershed flow information will yield appropriate levels of regeneration per watershed
{F-2} Land managers and developers may unwittingly disturb important Atlantic salmon habitat through various land use activities including forest practices	ÎThe Atlantic Salmon Authority completes its habitat mapping and assessment work	high	low	Atlantic Salmon Authority	1997	$45,192	This information is critical to both regulatory and local river groups efforts to protect the most important salmon habitat. State law has referred to these areas as worthy of heightened scrutiny since 1988.
({F-2} continued) Land managers and developers may unwittingly disturb important Atlantic salmon habitat through various land use activities including forest management	ÏThe State Planning Office, Atlantic Salmon Authority and the Maine Department of Inland Fisheries and Wildlife will cooperatively work with landowners to develop binding and enforceable Memoranda of Agreement (MOA) and conservation easements for the protection of all important Atlantic salmon habitat.	high	medium	SPO, ASA, IF&W	1997-2001	$40,000*	A higher degree of cooperation and protection is anticipated when working directly with willing landowners than impressing new regulations upon them.

same as above	ÐIn the absence of comprehensive landowner MOAs or conservation easements, the Land & Water Resources Council will evaluate the designation of "Significant Atlantic salmon Habitat" or Fish and Wildlife Protection Subdistricts under NRPA and LURC, respectively.	high	medium	LWRC	1999		In order to equitably establish consistent standards and ensure comprehensive protection of the most important habitat, it may still be necessary to use a regulatory approach.
({F-2} continued) Land managers and developers may unwittingly disturb important Atlantic salmon habitat through various land use activities including forest management	ÑDEP , working with landowners and others, will direct their efforts with municipalities to strongly encourage them to place "significant Atlantic salmon habitat" in a Resource Protection zone where appropriate.	high	low	DEP, SPO, ASA	1999	$7,000*	Redirecting shoreland activities away from these areas or directly upstream of these areas will go a long way toward minimizing potential habitat damage
same as above	ÒLURC, working with landowners and others, will incorporate, where appropriate, Atlantic salmon habitat mapping by rezoning these areas to a Fish and Wildlife Protection Subdistrict as the information becomes available. The Commission will also need to work with the Atlantic Salmon Authority to develop appropriate standards for activities in the new protection subdistricts	high	high	LURC, ASA	2000	$2,500*	Redirecting shoreland activities away from these areas or directly upstream of these areas will go a long way toward minimizing potential habitat damage
{F-3} Skid trails, road	ì&❷ -Working with						ì&❷Current regulations

construction, maintenance, & placement may cause secondary impacts that effect salmon such as: ❶ sedimentation which may clog spawning beds & hinder alevin emergence; ❷ poor culvert installation which blocks fish passage; and ❸ increased access which may create greater fishing pressure	landowners, resource managers, and appropriate state agencies, the Maine Forest Service will revise and update BMPs based on the findings of recent BMP assessment study. -State agencies will work with Project SHARE to design and implement an ongoing program to educate road building and logging contractors and landowners on the importance of Atlantic salmon habitat and to promote the use of forestry BMPs. îResource agencies working with Project SHARE, landowners, and others will cooperatively monitor key access points and control access where necessary and appropriate.	medium low	high low	Maine Forest Service/ DEP/ LURC/SPO, Local Watershed Conservation Organizations ÐProject SHARE / IF&W / Angling groups / Landowners	1996 and beyond 1997, 1998	ì&❷ $25,000* î $10,000	and BMPs are believed to be effective in controlling sedimentation provided guidelines and rules are complied with. Targeting sensitive habitat areas will add a measure of protection not currently in place. As new data becomes available, BMPs may need to be updated. îResponsibility for managing increased access must be shared by state agencies, landowners, and anglers alike.
{F-4} Increased temperatures and algal blooms from excessive shade removal along streams can adversely affect Atlantic salmon survival by changing their feeding, reproductive, and migratory behavior, reducing suitable rearing habitat and available cold water refugia , and eliminating macroinvertebrate habitat	ÎIncreased enforcement and compliance monitoring of shoreland harvesting ÏEducate logging contractors and resource managers to be sensitive to shading needs when planning tree harvesting in shoreland areas. ÐLandowners working through the "Sustainable Forest Initiative" (SFI) program of forestry and conservation practices	moderate high high	high high	DEP / LURC/ IF&W/ Forest Service, and local conservation organizations Project SHARE / Forest Service	1996 and beyond 1997 and beyond	Î $20,000*	Current shoreland regulations require a % of shading to be left intact. Regulations appear to be adequate for areas they cover. Regulations alone will not help harvesters make good onsite decisions. Additional information about shading will result in better tree selection. Industry is moving toward integrating principles of sustainability and

	conservation practices will provide education material and promote the use of streamside management BMPs in Atlantic salmon river watersheds.		high	landowners	1996 and beyond		sustainability and enhance stewardship. They can provide leadership and expertise to further their conservation goals and protect Atlantic salmon
{F-5} Excessive woody debris blocking fish passage, restricting stream flow, and reducing dissolved oxygen	Support Project SHARE, Ducktrap River Coalition, and the Sheepscot Valley Conservation Association and local watershed conservation groups to remove blockages with advice from fisheries biologists	moderate	high	Project SHARE/ local river groups / IF&W	ongoing		A systematic approach to removing blockages will increase available spawning and nursery habitat in streams. Care should be taken to leave woody debris that is functioning as protection for holding pools.
{F-6} Direct and indirect sublethal effects to salmon from improper use of chemical pesticides and use of pesticides that are toxic to aquatic organisms	Î DEP, ASA, & BPC will review will review the geographic usage of pesticides in the seven watersheds and DEP will target areas for in-stream assessment. Ïthe Board of Pesticide Control will work cooperatively with state agencies and the University of Maine Co-operative Extension Service to update best management practices based on the latest research and promote the use of these practices within the seven river watersheds. Ðthe Board of Pesticide Control will respond to evidence of pesticides causing adverse environmental effects by proposing amendments to its regulations, updating best management practices, and changing product registration	medium low high	high high low	DEP, BPC, ASA BPC/ Univ. of ME. Board of Pesticide Control	1998, 1999, 2000 1997 ongoing 1997 ongoing	$15,000*	The state does not have the means nor the process to determine which chemical products are being used in a given watershed, whether they are getting into streams, and whether they are at levels to cause habitat modification or fish mortality

	status where appropriate.						

Appendix 1

Federal Outline of Threats/Actions

a) Detailed description of the proposed activity:

- **{F-1} % of watershed in a regenerating forest condition effects water flow dynamics which may alter available habitat**

Dates and duration of the activity:

Specific location: ubiquitous

b) Anticipated impact of the proposed activity in the species (amount, extent, and type of taking)

unknown

c) Anticipated impact of the proposed activity on the habitat of the species

Potential impacts on local, sub-watersheds from abrupt and gradual changes in forest cover may affect water yield to small streams with high Atlantic salmon habitat value. Moreover, local stream flow increases associated with a reduction in basal area may be particularly significant to an individual prime spawning area but relatively insignificant in the entire watershed. Information about the importance of possible elevated stream flows both at specific sites and the entire watershed will be important for habitat protection efforts.

d) steps (specialized equipment, methods of conducting activities, or other means) that will be taken to monitor, minimize, and mitigate such impacts, and the funding available to implement such measures

1) Forest Service and landowners will cooperatively assess the potential for abnormal flow in the watersheds using remote sensing and model hydrology dynamics and present findings to local watershed councils.

e) alternative actions to such taking that were considered and reasons why those alternatives were not used

1) restrict harvesting in the watersheds to a particular, abritrary threshold

2) do not conduct any analysis, assuming the impacts are slight

f) list of all sources of data used in the preparation of the plan, including reference reports, environmental assessments and impact statements, and personal communication with recognized experts on the species or activity who may have access to data not published in current literature.

Hornbeck et al. 1993
Hornbeck and Leak. 1991
Leonard 1961

Appendix 1

Federal Outline of Threats/Actions

a) Detailed description of the proposed activity:

{F-2} Land managers and developers may unwittingly disturb important Atlantic salmon habitat through various land use activities including forest management.

Dates and duration of the activity:

no specific time of year

Specific location:

at key places along the 7 salmon river and tributary streams

b) Anticipated impact of the proposed activity on the species (amount, extent, and type of taking)

The magnitude or result of the lack of knowledge about precise locations of critical Atlantic salmon habitat is difficult to measure. There is no direct or indirect effect on the species.

c) Anticipated impact of the proposed activity on the habitat of the species

The effect of the lack of habitat information could be significant. The extent of damage to or eradication of Atlantic salmon habitat from the absence of information is difficult to determine. It is safe to assume that human activities will eventually impact upon prime Atlantic salmon habitat unless resource user know when and how to steer clear of these areas.

d) steps (specialized equipment, methods of conducting activities, or other means) that will be taken to monitor, minimize, and mitigate such impacts, and the funding available to implement such measures

1. The Atlantic Salmon Authority will complete its habitat mapping and assessment work.

2. The Atlantic Salmon Authority and the Maine Department of Inland Fisheries and Wildlife will cooperatively work with landowners to develop binding and enforcable Memoranda of Agreement (MOA) for the protection of all important Atlantic salmon habitat.

3. In the absense of comprehensive landowner MOAs, the Atlantic Salmon Authority will petition regulatory agencies to zone "Significant Atlantic salmon Habitat"with appropriate standards for appropriate activities.

4. DEP, working with landowners and others, will direct their efforts with municipalities to strongly encourage them to place Significant Atlantic salmon Habitat in Resource Protection zones where appropriate.

5. LURC, working with landowners and others, will incorporate, where appropriate, Atlantic salmon habitat mapping by rezoning these areas to Fish and Wildlife Protection Subdistricts as the information becomes available. The Commission will also need to work with the Atlantic Salmon Authority to develop appropriate standards for activities in the new protection subdistricts.

e) alternative actions to such taking that were considered and reasons why those alternatives were not used

1) Do not collect and disseminate Atlantic salmon habitat information.

- in violation of Maine Legislature's intentions;
- against forest management principles of using the best available information to make informed decisions

2) Seek to designated all streams and rivers in the 7 river watersheds as significant Atlantic salmon habitat.

- unnecessary and impracticable

f) list of all sources of data used in the preparation of the plan, including reference reports, environmental assessments and impact statements, and personal communication with recognized experts on the species or activity who may have access to data not published in current literature.

Correspondence with Randy Spencer, fish biologist with the ASA, 1995.
Correspondence with Melissa Evers, fish biologist with the ASA, 1996.
Correspondence with Lewis Allen, DEP 1995.
Correspondence with dan Prichard, DEP 1995.
Correspondence with Tracy Copeland, U.S Fish & Wildlife Service. 1996.
Maine Natural Resources Protection Act, 1988
Maine Land Use Regulation Commission Districts and Standards, Chapter 10. 1991
(DEP 1994)
(Barton and Taylor. 1985)
(Comerford et al. 1992)
(Hornbeck. 1986.)
(Rowe. 1975)

Appendix 1

Federal Outline of Threats/Actions

a) Detailed description of the proposed activity:

{F-3} Skid trails, road construction, maintenance, & placement may cause secondary impacts that effect salmon such as: 1) sedimentation which may clog spawning beds & hinder alevin emergence; 2) poor culvert installation which blocks fish passage; and 3)increased access which may create greater fishing pressure

Dates and duration of the activity:

1 & 2 Usually in all but the winter months
3 During the recreational fishing season

Specific location:

no specific location

b) Anticipated impact of the proposed activity on the species (amount, extent, and type of taking)

1) Direct evidence from research from New England salmon waters confirms there is high mortality during the salmon's alevin intragravel stage. Introducing high levels of sediments during a vulnerable life stage of Atlantic salmon may increase mortality rates by trapping and/or suffocating alevins so they cannot leave that environment. The extent of alevin mortality and any increased mortality associated with sedimentation in the 7 Atlantic salmon rivers is not currently known.

3) Figures do not presently exist concerning illegal fishing on the 7 salmon rivers. One can only speculate that easy access to favored fishing areas allows for a greater chance of poaching. Specutively, the magnitude of impact from illegal fishing on Atlantic salmon is not considered substantial.

c) Anticipated impact of the proposed activity on the habitat of the species

1) Sediment in salmon streams and rivers results in habitat loss by clogging stream bed gravel which in turn compromises embryo survival and eliminates spawning areas. Another consequence of forestry related sedimentation is a decrease in macroinvertebrate density in streams due to burying of their habitat. Decreasing a food source for salmon may lead to population declines.

2) Poorly placed or undersized culverts (usually from road building and maintenance) can also hinder fish passage, effectively reducing access to potential habitat.

The extent or existence of habitat loss in the 7 river watersheds from road building and maitenance activities is unknown.

d) steps (specialized equipment, methods of conducting activities, or other means) that will be taken to monitor, minimize, and mitigate such impacts, and the funding available to implement such measures

1) Working with landowners, resource managers, and appropriate state agencies, the Maine Forest Service will revise and update BMPs as per the evolving recommendations of the Maine Council on Sustainable Forest Management.

2) State agencies will work with Project SHARE to design and implement an ongoing program to educate road building and logging contractors and landowners on the importance of Atlantic salmon habitat and to promote the use of forestry BMPs.

3) Landowners working through the "Sustainable Forest Initiative" (SFI) program (see Appendix (3.) of forestry and conservation practices will provide education material and promote the use of road construction BMPs in Atlantic salmon river watersheds.

4) Resource agencies working with Project SHARE, landowners, and others will cooperatively monitor key access points and control access where necessary and appropriate.

e) alternative actions to such taking that were considered and reasons why those alternatives were not used

1) Prohibit all roads within a defined riparian zone.

Current road building standards and BMPs are considered adequate to reduce ecessive sedimentation from road building.

2) Remove and replace all culverts

Too expensive and unnecessary. Project SHARE is identifying key blockages and impediments to fish passage and targetting them for removal or updating.

3) Close all motorized access to salmon rivers and streams.

Would not allow legal anglers the chance to access the rivers and streams

f) list of all sources of data used in the preparation of the plan, including reference reports, environmental assessments and impact statements, and personal communication with recognized experts on the species or activity who may have access to data not published in current literature.

(Moring and Finlayson. 1996.)
(MacDonald et al. 1991.)
(Taylor. 1989.)
Correspondence with Ron Brokaw, Fish Biologist, Maine IF&W. 1995.
Draft report, "Assessing Compliance with BMPs on Harvet Sites in Maine." May 1996.
(Stafford et al. 1995.)
(DeHart. 1982.)
(Furniss et al. 1991)

Appendix 1

Federal Outline of Threats/Actions

a) Detailed description of the proposed activity:

- **{F-4} Increased temperatures and algal blooms from excessive shade removal along smaller tributary streams can adversely affect juvenile Atlantic salmon survival by reducing suitable rearing habitat and available cold water refugia during periods of prolonged high temperatures and reducing macroinvertebrate habitat.**

Dates and duration of the activity:

June, July, August, September

Specific location:

unknown

b) Anticipated impact of the proposed activity on the species (amount, extent, and type of taking)

The scientific literature on the effects of temperature increases on salmonoid behavior shows changes in spawning and feeding habits. Further, temperature is known to effect incubation and egg mortality and to alter timetables for salmon life cycle events such as downstream passage. The extent or existence of forestry related temperature increases in the 7 river watersheds in unknown. We believe the occurrences of excessive shade removal are limited due to current regulations and BMPs or are confined to small headwater streams that are currently un and underegulated. Any estimate on actual incidental take due to shade removal would be conjecture.

c) Anticipated impact of the proposed activity on the habitat of the species

Temperature increases probably impact individual species more than habitat, however, algal blooms and changes to macroinvertebrate density both can reduce Atlantic salmon habitat by shrinking the available food supply. Unshaded areas combined with increased temperatures also may mean less places where Atlantic salmon may seek refuge. As with b above the extent of habitat reduction from excessive shade removal in the 7 river watersheds in unknown.

d) steps (specialized equipment, methods of conducting activities, or other means) that will be taken to monitor, minimize, and mitigate such impacts, and the funding available to implement such measures

1) Increased enforcement and compliance monitoring for shoreland harvesting and revise forestry best management practices to increase their use and effectiveness.

2) Educate logging contractors and resource managers to be sensitive to shading needs when planning tree harvesting in shoreland areas.

3) Landowners working through the "Sustainable Forest Initiative" (SFI) program of forestry and conservation practices will provide education material and promote the use of streamside management BMPs in Atlantic salmon river watersheds.

e) alternative actions to such taking that were considered and reasons why those alternatives were not used

1) Prohibit timber harvesting in riparian areas.

- Since current regulations and BMPs address shading of most streams, this measure would be excessive.

2) Further restrict shade removal in regulated areas.

- Current regulations coupled with BMPs appear adequate.

3) Rely sole upon current regulations governing timber harvesting in shoreland areas

- The Maine Council on Sustainable Forest Management is examining the comprehensiveness of current regulations and may determine that additional measures can be taken to supplement existing regulations to further reduce the effects of harvesting on stream water temperatures.

f) list of all sources of data used in the preparation of the plan, including reference reports, environmental assessments and impact statements, and personal communication with recognized experts on the species or activity who may have access to data not published in current literature.

(Elliot. 1991.)
(Shepard. 1995.)
(Danie et al. 1984)
(Scrivener & Anderson. 1984.)
(Cave. 1985.)
(Moring & Finlayson. 1996.)
(Platts & Nelson. 1989)
(Graynoth. 1979.)
(Elson. 1975.)
(Kazokov & Khalyapina. 1981.)

Appendix 1

Federal Outline of Threats/Actions

a) Detailed description of the proposed activity:

{F-5} Excessive woody debris blocking fish passage, restricting stream flow, and reducing dissolved oxygen

Dates and duration of the activity:

anytime

Specific location:

no specific location

b) Anticipated impact of the proposed activity on the species (amount, extent, and type of taking)

This threat is not considered a risk to individual species.

c) Anticipated impact of the proposed activity on the habitat of the species

- Woody debris blocking fish passage effectively reduces the area in which Atlantic salmon may feed, hide, and spawn. The extent of habitat reduction from debris blockages in the 7 river watersheds is unknown.

d) steps (specialized equipment, methods of conducting activities, or other means) that will be taken to monitor, minimize, and mitigate such impacts, and the funding available to implement such measures

- Support Project SHARE, Ducktrap River Coalition, and the Sheepscot Valley Conservation Association and local river groups to remove blockages with advice from fisheries biologists.

e) alternative actions to such taking that were considered and reasons why those alternatives were not used

1)Remove all hinderences without a fish biologist's blessing.

- Doing so may result in more harm than benefit. A carefully designed program will target those blockages that are not providing any benefit to Atlantic salmon.

2) Leave all woody debris.

- The potential for increasing available Atlantic salmon habitat would not be realized.

f) list of all sources of data used in the preparation of the plan, including reference reports, environmental assessments and impact statements, and personal communication with recognized experts on the species or activity who may have access to data not published in current literature.

Correspondence with Ron Brokaw, Maine IF&W fish biologist.
(Moring and Finlayson. 1996.)
(Moring et al. 1994.)
(Bilby & Likens. 1980.)
(Bryant. 1983.)
(Fausch & Northcote. 1992.)

Appendix 1

Federal Outline of Threats/Actions

a) Detailed description of the proposed activity:

{F-6} Direct and indirect sublethal effects to salmon from improper use of chemical pesticides and use of pesticides that are toxic to aquatic organisms.

Dates and duration of the activity:

- Herbicides are normally applied in September. Insecticides may be applied during the summer months.

Specific location:

no specific location

b) Anticipated impact of the proposed activity on the species (amount, extent, and type of taking)

Certain forest chemicals are known to range from toxic to extremely toxic to fish. The effects of exposure to pesticides can be both direct and indirect. Atlantic salmon are at greatest risk when pesticides are applied directly to a stream or river. Current regulations and product labeling forbid the application of pesticides directly to a water body and control the drift of aerial applications into streams, river, and wetlands. There is currently no evidence to suggest that the proper use of forest pesticides results in Atlantic salmon mortality.

c) Anticipated impact of the proposed activity on the habitat of the species

Pesticides can alter macroinvertebrate habitat and even cause temporary loss of insect density. This condition can impact Atlantic salmon by temporarily reducing available food. If the habitat is not producing enough food for the resident Atlantic population then it is no longer a well functioning ecosystem. There is no evidence to suggest that Atlantic salmon habitat is permanently altered by the legal application of forest pesticides.

d) steps (specialized equipment, methods of conducting activities, or other means) that will be taken to monitor, minimize, and mitigate such impacts, and the funding available to implement such measures

1) DEP, ASA, & BPC will review the geographic usage of pesticides in the seven watersheds and DEP will target areas for in-stream assessment.

2) The Board of Pesticide Control will work cooperatively with state agencies and the University of Maine Co-operative Extension Service to update best management practices based on the latest research and promote the use of these practices within the seven river watersheds.

3) The Board of Pesticide Control will respond to evidence of pesticides causing adverse environmental effects by proposing amendments to its regulations, updating best management practices, and changing product registration status.

e) alternative actions to such taking that were considered and reasons why those alternatives were not used

1) Ban all pesticide use in the Atlantic salmon river watersheds.

While some pesticides are known to be hard on aquatic organisms, it is generally believed that current regulations and product labeling requirements are sufficient to protect fish.

2) Ban certain products from use.

The strict use of Best Management Practices of pesticides, in effect, negates the use of the most toxic pesticides. Also, strict adherence to product labeling and drift regulations minimizes potential risks to Atlantic salmon and their habitat.

f) list of all sources of data used in the preparation of the plan, including reference reports, environmental assessments and impact statements, and personal communication with recognized experts on the species or activity who may have access to data not published in current literature.

(Norris et al.1991)
(Correspondence with Gary Fish, Maine Board of Pesticide Control, 1996)
(Correspondence with Robert Batiesse, Maine Board of Pesticide Control, 1996)
(Haines. 1981)
(Holtby and Baillie. 1989)
(Hulbert. 1978)
(Kreutzweiser et al. 1992)
(McCormack. 1994)
(McKellar et al. 1982)
(Newton. 1984)
(State of Maine. 1990)
(Cline et al. 1990)
(Administrative Rule, BPC. 1988)
(Smith & McCormack. 1988)
(Trial. 1986)
(Stafford et al. 1995)

Appendix 2

Management Authorities in the State

Generally, the State boasts an array of statutes, rules, and programs to safeguard water quality within Maine's great ponds, rivers, streams, brooks and wetlands. Many of the laws protecting these resources focus on minimizing nonpoint source pollution while a smaller number regulate point source discharges into water bodies. People widely believe that the sum total of these laws has significantly improved fresh, surface water quality throughout the state over the last 10-15 years. Specifically, standards for road construction and water crossings have reduced the incidences of sedimentation and site erosion. According to forest road engineers and fisheries biologists, roads constructed since 1980 constitute a low risk to degrading Atlantic salmon habitat.

The Department of Environmental Protection (DEP), Land Use Regulation Commission (LURC), Maine Forest Service, the Board of Pesticide Control, and individual municipalities oversee and administer several protection statutes. With the exception of laws particular to the LURC or municipalities, Maine environmental statutes apply statewide. Recently however, the legislature, in an attempt to reduce duplicate regulations, has granted the LURC sole jurisdiction over activities in certain natural resources such as rivers, streams, brooks, and great ponds. The LURC, acting as a local planning board, is responsible for regulating land use activities in the unorganized areas (roughly 1/2 the state's land area), whereas, the DEP concentrates its efforts in the organized municipalities. Any assessment of forestry's potential impacts needs to account for the different rules and standards being applied to the organized and unorganized portions of the state.

i. Natural Resources Protection Act (NRPA) (38 MRSA ' 480-A et seq.)

This law protects certain natural resources including great ponds, rivers, streams and brooks, coastal wetlands (including intertidal areas), freshwater wetlands, and significant wildlife habitat. Notably, the NRPA specifically defines significant wildlife habitat to include "critical spawning and nursery areas for Atlantic sea run salmon as defined by the Atlantic Sea Run Salmon Commission." A state permit from DEP is required for dredging, draining, filling and construction in, on, over, or adjacent to these areas (38 MRSA ' 480-C) . To grant a permit, DEP must make certain findings, including that the activity will not cause unreasonable soil erosion or inhibit natural sediment transfer; will not unreasonably interfere with the natural flow of the water; and will not violate any state water quality law including those governing classification of state waters (38 MRSA ' 480-D).

A permit is not required for forestry operations in forested wetlands if they comply with the following standards:

* the activity results in a forest stand that meets minimum stocking requirements;
* the activity meets Permit-by-Rule standards for soil disturbance and stream crossings;
* the forested wetland is not mapped as a significant wildlife habitat; and
* any road construction is used primarily for forestry operations and not development.

A permit is required if the forested wetland has been mapped a significant wildlife habitat.

Permit-by-Rule standards (see Appendix A) are designed to minimize sedimentation and erosion resulting from activities within 25-100 feet of a water body or wetland or at stream, river, and brook crossings. An individual permit is needed for activities exceeding the standards.

ii. Mandatory Shoreland Zoning Act (38 MRSA ' 483-A et seq.)

The "Shoreland Zoning Act" requires all Maine municipalities to adopt a shoreland zoning ordinance, consistent with minimum requirements set forth by the DEP, to regulate activities within 250' of a great pond, wetland, rivers, and coastal waters and within 75' of larger streams. The minimum requirements include standards for timber harvesting and road construction within shoreland areas (see Appendix A). Areas designated as "Resource Protection" are the most restricted in terms of forestry activities often requiring a permit or not allowing the activity altogether within 75' of the or surface water's normal high water mark. Ten to 30% of the shoreland areas are estimated to be represented as Resource Protection. Towns are encouraged to apply a Resource Protection zone to areas containing "significant wildlife habitat." As defined within the NRPA, these areas may include critical spawning and nursery areas for Atlantic sea run salmon as defined by the Atlantic Sea Run Salmon Commission (Atlantic Salmon Authority).

The statute also establishes special protection for significant river segments which include portions of the Pleasant, East Machias, Machias, and Narraguagus Rivers. Municipalities are required to apply standards for principal structures, new roads, and new gravel pits along these river segments designed to protect "their scenic beauty and unspoiled character." The standards establish setbacks from the river for these activities.

Forty-eight of the 57 municipalities within the 7 river watersheds adopted local shoreland zoning ordinances. The remaining 9 have had an ordinance adopted by DEP for them. Three of the towns have exceeded the minimum standards for forest management activities (Alna, Boothbay, and Dennysville) with the remainder relying on the minimum requirements.

iii. Waste Discharge Law (38 MRSA ' 413)

No person may directly or indirectly discharge any pollutant (including rock, sand and dirt) to any water of the State without a license. This law applies to discharges of pollutants from forestry activities.

iv. Forest Products Refuse (38 MRSA ' 417)

No person may deposit or discharge forest refuse (i.e. slabs, edgings, sawdust, shavings, chips, bark, etc.) directly or indirectly on into any inland waters or tidal waters of the state or onto the banks thereof such that the refuse may flow or leach into these waters.

v. Pesticide Control Laws (7 MRSA ' 601 et seq.; 22 MRSA ' 1471-A et seq.)

The Board of Pesticides Control has the primary responsibility to regulate the sale and use of pesticides in Maine. One of the Board's major functions is to register the more than 6,000 products that are available for sale and license more than 3,000 applicators. Applicators are required to follow federally prescribed standards on product labels and the Board's regulations.

No person may apply or cause to be applied a pesticide to the waters of the state without obtaining a waste discharge license from the Department of Environmental Protection. No person shall apply pesticides to any area of the state which is designated by the Board of Pesticides Control (BPC) as a critical area, except as directed by the BPC. The BPC may designate critical areas which shall include areas where pesticide use would jeopardize endangered species or critical wildlife habitat, present unreasonable threat to the quality of a water supply, be contrary to a master plan promulgated by a state or federal agency, or would otherwise result in unreasonable adverse effects on the public health, welfare or the environment.

The BPC has designated the Deblois Fish Hatchery (within the Narraguagus River watershed) and a stretch of the Dennys River from lower dam at Meddybemps Lake to Gilman Dam at the mouth of the River at Dennys Bay. The Deblois critical areas includes 1000' around the hatchery itself and around the tributary streams supplying water to the hatchery. The Dennys River critical area ranges from 1/2 mile to 1 mile from the banks of the river. Within these critical areas, the use of pesticides is limited and restricted. According to a BPC official, justification for these designations stem from concerns about insecticide drift associated with spruce budworm spraying and a drift incident in 1979 in Dennysville raising public concerns. Since then, the designation has not been challenged.

Public and private forest aerial insecticide applications require pre-application public notice. Water bodies within 500 ft of the spray must be identified on a map. Weather conditions are to be considered when conducting aerial sprays, and these activities are prohibited when winds exceed 15 mph. Aerial sprays require spotters and monitors and a written report must be filed with the BPC by the spray monitor describing the spray activity. Before spraying, landowners may develop a drift management plan allowing the BPC to grant some management flexibility for the spray operation.

Rules do not exist specificly requiring setbacks to rivers, streams, and brooks for the aerial application of pesticides. However, applicators must adhere to standards on product labels and prohibitions set by the BPC to safeguard sensitive water resources. Chapter 22, BPC rules for pesticide application with power equipment, sets standards for minimizing off-target drift. The BPC considers drift regulations an alternative to buffering requirements. Champion International Corporation voluntarily buffers all wetlands, ponds, lakes, streams, and rivers from aerial spray applications of herbicides.

vi. Land Use Regulation in the Unorganized Territories (12 MRSA ' 681 et seq.)

The Land Use Regulation Commission (LURC or "the Commission") regulates some timber harvesting and road construction in Maine's unorganized territories. The unorganized territories are zoned into three districts: Development, Management and Protection (12 MRSA ' 685-A). Areas around water bodies are placed in various Protection subdistricts (LURC Rules, Ch.10.16). In Protection subdistricts that are associated with water bodies (fish and wildlife, great ponds, shoreland, wetlands) timber harvesting and road construction must comply with specific standards (LURC Rules, Ch. 10.17). Many of these standards (see Appendix A) form the basis of best management practices (BMPs) for forest management activities. A permit is required from the Commission for timber harvesting in all Development districts and certain Protection subdistricts (mountain areas, recreation protection and soils & geology protection). Finally, timber harvesting is allowed in all Management districts without regulation (LURC Rules, Ch.10 Summary).

The land in the 7 river watersheds within the Commission's jursidiction is predominately zoned as a General Management District. A much smaller portion comprising all lakes and non-forested wetlands (greater than 10 acres), and rivers, streams, and brooks (any size) is surrounded by shoreland protection subdistricts. As noted earlier, the Commission regulates timber harvesting by imposing standards in these areas.

The Commission's Fish & Wildlife Protection Subdistrict is, in part, defined as "significant fish spawning nursery and feeding areas and critical habitat of endangered and threatened fish and wildlife species" (Dept. of Conservation, 1991). While specific areas within the watersheds are zoned as a protection subdistrict for deer, none have been designated as yet to protect fish habitat.

Watershed	LURC Jurisdiction	% of Total	Municipal Jurisdiction	% of Total
Sheepscot	0.75 square miles	00.3	295.23 square miles	99.7
Ducktrap	0	0	34.66	100
Narraguagus	138.22	57	104.31	43
Pleasant	54.78	43.9	69.99	56.1
Machias	366.57	73.6	131.09	26.4
East Machias	151.74	48.6	160.23	51.4
Dennys	43.75	11.5	335.91	88.5

TOTALS	755.81	40.04	1131.42	59.96

vii. Forest Practices Act (12 MRSA ' 8867 et seq.)

Any landowner who intends to harvest forest products for commercial purposes must file a notice with the Maine Forest Service (MFS) prior to starting the harvesting operation (12 MRSA ' 8883). This notice describes the size and location of the harvest. Exceptions to this requirement include harvests for personal use; pre-commercial silvicultural practices; and harvesting of Christmas trees and boughs, maple syrup, cones and other seed products. Failure to file such a notice is punishable through fines and stop work orders. This law is enforced by MFS field staff who check on noticed and unnoticed harvests. During these inspections, water quality problems are identified and corrected. If the problem persists, it is reported to the DEP Water Bureau and/or the local Code Enforcement Officer for enforcement.

The Act promotes harvesting in areas where hardwood and softwood regeneration is well established. This method, allows harvested areas to be stabilized rapidly and reduces nonpoint source pollution.

Clear cuts greater than 35 acres in size must have a forest management plan prepared by a professional forester that outlines the activities to regenerate, improve and harvest timber which conforms to the revegetation and clearcutting standards (12 MRSA ' 8869). Among other things, this plan shall include the following:

* location of water bodies;

* significant wildlife habitats identified by the Department of Inland Fish and Wildlife;

* an explanation of how the harvest will comply with the regeneration and clearcutting standards; and

* an assessment of soil erosion potential of the harvest area (including roads) and any actions necessary to minimize erosion.

A plan may also include schedules and further recommendations for timber stand improvement, harvesting plans and recommendations for regeneration activities.

From 1991 to 1993, 74% of all reported clearcuts were under 35 acres in size, 23% were from 36 to 125 acres in size, and 3% ranged from 126 to 250 acres. During this period a total of 187,673 acres were clearcut statewide (Maine Forest Service, 1995). In the Downeast region, of the 54,603 acres (annual average from 1991-1993) that were harvested, 7,216 acres (annual average) or 13% were clearcut.

viii. Tree Growth Tax Law (36 MRSA ' 565 et seq.)

This law allows a landowner of more than 10 acres of forested land that is held for potential commercial use to obtain a revaluation of his property based upon the forest product value, rather than the development value. This results in a savings on the local property tax which acts as an incentive for landowners to protect the commercial forest land base. One requirement for this program is that the landowner must file an affidavit with the town'stax assessor that a forest management plan has been prepared by a licensed professional forester which outlines the intended activities to regenerate, improve and harvest timber. This plan must also include the location of water bodies and wildlife habitat.

Guidelines for forest management and harvest management plans require mapping the area to be harvested, including the location of water bodies and wildlife habitat. They also require outlining the activities to regenerate, improve and harvest the timber. This outline is recommended to include site specific management actions for site preparation, tree planting, thinning, pruning, direct seeding, site conversion, weeding, cleaning, timber harvesting and timber salvage. A harvest plan is also required which shows the time schedule and approximate volume to be removed, and makes recommendations to insure regeneration after the harvest. For land placed in tree growth after September 30, 1989, the landowner must get certification from a licensed forester stating that the management plan is still being followed after 10 years. For land placed in tree growth prior to September 30, 1989, the same certification is not required until April 1999.

Appendix 3

Voluntary Protection Initiatives

i. Project SHARE (Salmon Habitat And River Enhancement)

Formed in mid-1994, Project SHARE is a voluntary association of landowners, businesses, government officials, researchers, educators, and conservation organizations committed to conserve and enhance Atlantic salmon habitat and populations in the Downeast region of Maine. Project SHARE is participating in a series of projects aimed at understanding and improving Atlantic salmon habitat and restoration. Among the projects directly related to forestry activities are a water temperature monitoring study, habitat mapping, and the promotion of training sessions for foresters and landowners on Atlantic salmon biology and habitat. Other projects have included installing a weir on the Dennys River, locating and removing several river blockages caused by log and debris buildup, working to complete construction of the Pleasant River Hatchery and Education Center, and repairing a fish ladder and water control gate at Meddybemps dam on the Dennys River. Project SHARE will likely play a key role in implementing many of the strategies called for in the state's conservation plan.

A list of Project SHARE Members and Cooperators are currently unviewable.

2. Sustainable Forestry Initiative, American Forest & Paper Association

The American Forest & Paper Association (AF&PA) developed a comprehensive program of conservation and forestry practices known as the Sustainable Forestry Initiative (SFI) to ensure that forests throughout the country will continue to provide a wide variety of industrial and environmental benefits. The Maine forest products conpamies have been working to integrate SFI principles and guidelines into their land management and procurement practices. These 12 principles include:

employ an array of scientifically, environmental, and economically sound practices to growth, harvest, and use of forests;

promptly reforest harvested areas;

ii. Riparian Management Zones, Champion International Corporation

Champion International is pursuing a company-wide "Sustainability and Stewardship Initiative" for their forest resources. Simply, the thrust of the new program is for Champion to maintain non-timber values (e.g. ecological diversity, wildlife habitat, water quality) as they develop policies, plan, and manage their forest lands. A component of the initiative is to self impose riparian management zones throughout the lands they manage. Cutting in these "Special Value" areas will be low volume, leaving enough canopy for wildlife cover and a wide range of various aged trees to help maintain species richness and diversity. Regarded as the most sensitive and dynamic landscape areas, the new zones are specifically designed to buffer aquatic and wetland wildlife from disturbance, prevent wetland and water quality degradation, and provide for important wildlife habitat.

Champion's policy recognizes that larger streams have more riparian values and should receive progressively greater protection as the stream gets larger. Further, the policy establishes narrow protection zones (75') for small ephemeral streams originating in the forest and wider zones as these streams merge with other streams. A 100' buffer will surround ephemeral, first and second order streams that are identified on 7.5 minute USGS quadrangles. Third, fourth , and fifth order streams will receive progressively wider buffers. Standards for activities and buffer widths are based on current scientific literature. On all streams, regardless of size, shading and streambank stabilization are high priorities. Champion intends to focus on "outcomes" for these areas when considering timber harvesting and road construction activities in the buffer areas ensuring that uneven aged and windfirm stands remain. In all cases, decisions about forestry activities in riparian areas will be aimed at maintaining non timber values.

The standards for forest management activities within these areas are slated to be more restrictive than those currently imposed by DEP, LURC, or any individual municipality.

Champion has adopted the riparian management zones and will be field testing their application for all their winter operations in the 5 Downeast river watersheds.

iii. Maine Nonpoint Source Management Program

Administered by DEP, this program concentrates on the identification and control of water pollution from nonpoint sources. A major component of the program is to advance the use of and develop best management practices (BMPs) for forest management activities. Typically, BMPs help to control erosion, limit the impacts of road construction and stream crossings, and temper the effects of other forest management activities such as slash placement and pesticide applications. As data are collected on the effectiveness of the BMPs, the guidelines for forest management activities are revised. The Maine Forest Service is spearheading efforts to improve BMPs using field information.

DEP, Maine Forest Service (MFS), and University of Maine are currently conducting an evaluation on the effectiveness of forestry BMPs. The study involves a statistical sampling of 120 harvested sites, identified through MFS timber harvesting notifications, that are evaluated using a BMP check list to determine how the measures are performing. Field work for the study was completed in September 1995 with a report slated to be completed by the summer of 1996.

iv. Code Enforcement Training and Local Shoreland Zoning Technical Assistance

The State Planning Office (SPO) and the DEP assists municipalities charged with enforcing shoreland zoning ordinances. SPO coordinates a code enforcement training program while the DEP shoreland zoning staff, in conjunction with Regional Planning Commissions, sponsors workshops, publishes newsletters, and directly consults with town officials on project reviews and enforcement issues in shoreland areas.

v. Sheepscot Valley Conservation Association

The Sheepscot Valley Conservation Association (SVCA), a volunteer conservation organization, has developed and implemented a water quality monitoring program. The program samples for bacteria, dissolved oxygen, nutrients and applies temperature probes. SVCA has published many of its findings and held workshops to raise awareness about the river's water quality. Moreover, SVCA shares it data with the Atlantic Salmon Authority who in turns uses the data for its habitat mapping effort.

vi. Ducktrap River Coalition

The Coastal Mountains Land Trust formed the Ducktrap River Coalition to focus attention on the river's small but important natural resources. The Coalition is comprised of 26 organizations whose long term goal is the protection of the river's resources. Currently, the Coalition is applying for grant money to augment their GIS mapping of critical watershed resources. Their information will be exchanged with the Atlantic salmon Authority. Additionally, the Coalition is providing a salmon rearing tank for the Lincolnville schools and scheduling meetings with landowners and town officials concerning their protection efforts.

vii. Status of Atlantic Salmon Habitat Mapping

The Maine Atlantic Salmon Authority (ASA), formerly the Atlantic Sea-Run Salmon Commission (ASRSC) and the U.S Fish & Wildlife Service are conducting Atlantic salmon habitat mapping and assessment. Efforts by the ASRSC, Maine IF&W, and the USFWS in the 1950s shaped the nature of future research and resulted in extensive historical data on the Atlantic salmon habitat. More recently in the mid-1980s, surveys on the East Machias and Sheepscot rivers were completed. Since then, the Dennys River watershed and the Machias and Narraguagus River systems were surveyed using established standard methodology for Atlantic salmon habitat identification. Each survey has yielded increasingly accurate habitat definition and geographic information. Global Positioning System (GPS) technology has provided a breakthrough for habitat mapping efforts.

Categories of critical Atlantic salmon habitat revolve around the various life stages of the salmon. Atlantic salmon habitat is typically designated as either spawning, nursery (juvenile rearing), or adult holding areas based on characteristics such as water depth, velocity, temperature, and bottom substrate composition. For example, spawning areas and deep pools that provide protection to adults and juveniles are areas that are highly valued and also vulnerable to change. Cool water refugia (spring seeps and deep pools), where they can be identified, are also very important habitat as they provide cool water during the summer months. Flowing riffles and rapids are essential for juvenile growth and survival. Spawning habitat, comprising a relatively small portion of each drainage, is also the most vulnerable to siltation or other disturbances. For example, the ASA has determined that only 5% of the Narraguagus River salmon habitat is suitable for spawning. Though undetermined, this figure is likely representative of the percentages of spawning areas found in the other rivers' salmon habitat.

The timetable for completion of the habitat mapping and classification work depends on available funding. Work completed by September 30, 1996 has been funded; work beyond that date is less certain. The table on the right shows probable completion dates assuming funds will be available.

The table showing the Anticipated Availability of Atlantic Salmon Habitat Maps is currently unavailable.

Appendix 4

Pesticides (Herbicides & Insecticides) Related to Forestry Use.

The following table shows figures for pesticide use statewide related to forest management. Note that pesticide use declined significantly after 1989 and has been rising slightly each year since then. While the use of insecticides is directly related to periodic insect infestations, herbicide use fluctuates with economic conditions. The table above indicates a steady increase in pesticide use since 1990, a year of relatively low economic growth for the paper and timber industries. Generally, timber companies will use herbicides as their silvicuture budget permits.

This Table is currently unavailable.

Herbicides

The accompanying list **(currently not viewable)** shows active ingredients in herbicides that have been, and are most likely to be, used in the forests within the watersheds of the 7 salmon rivers. These chemicals are used to manage for the commercially desirable tree species by reducing their competition. Of these the most commonly used are glyphosate (Roundup J , Accord J , Vision J , Rodeo J) and triclopyr (Garlon J).

Standards for the use of these herbicides are found on product labels. Labeling demonstrates the herbicide is registered by the the U.S. EPA and provides directions for using the product in a legal and proper manner. Most scientists and foresters believe that strict adherence to the product label protocols and standards results in negligible impacts to non targeted species. Neither labels or regulations require any buffer requirement for aerial spraying near a water body. Direct application to rivers, stream, brooks, pond, and lakes is forbidden.

Glyphosate

The literature on the environmental impacts of glyphosate reveal a low risk factor for certain aquatics, including coho salmon and invertebrates. For example, in 1984, Newton et al studied the fate of glyphosate in a forest watershed ecosystem and determined that coho salmon fingerlings did not accumulate detectable amounts of the herbicide (Newton et al, 1984). Furthermore, other studies conclude that manufacturers use rates for Roundup J do not adversely affect the ability of coho salmon smolts to adapt to seawater and to osmoregulate (Mitchell et al, 1987). According to Comes et al, glyphosate can travel long distances in water, however it is quickly absorbed onto clay and organic matter. A study of glyphosate in a forest ecosystem determined its half-life to range from 10 to 29 days in foliage and forest litter and twice as long in soil (Newton et al, 1984). Due to soil absorption, glyphosate does not easily leach in soil and has a low propensity for runoff (Reuppel et al, 1977).

To date, the most comprehensive look at the use of glyphosate comes from a 1989 controlled study and follow up conference known as the Carnation Creek Herbicide Workshop in British

Columbia, Canada. One of the studies demonstrated that 120 coho salmon fingerlings suffered no unusual mortality or signs of long term stress after the tributary where they reside was oversprayed (Holtby and Baillie, 1989). The conclusions of the conference were that Roundup, when applied in doses consistent with product labeling and using a specific helicopter spray method and equipment (Mircofoil Boom), has an impact on the environment that is short lived and confined to the target area. Moreover, traces of the product are barely detectable shortly after application.

Triclopyr

Studies on triclopyr indicate that Garlon 3A is only slightly toxic to non toxic to fishes and invertebrates. Garlon 4 has proven to be highly toxic to juvenile coho salmon (Johansen and Green 1990), rainbow trout, and bluegills (Norris et al. 1991), and slightly toxic to aquatic insects (Kreutzweiser et al. 1992).

Concentrations of Garlon 3A at levels typically associated with forestry applications are considered non toxic to fish (McKellar et al. 1982 & Norris et al. 1991). Furthermore, studies documenting the transport characteristics of triclopyr show that it rapidly photodegrades in water and is not absorbed by soil particles.More importantly, triclopyr is largely undetectable in streams in areas where buffer strips are employed (Smith and McCormack. 1988). Triclopyr's movement to waterbodies is limited.

Recent Industry Trends

Over the last several years, Champion International Inc. has selectively applied herbicides for softwood release in small portions of their land holdings. Treatment of these areas is on a 45 year rotation. Champion currently manages approximately 342,000 acres the five downeast river watersheds.

	1992	**1993**	**1994**	**1995**
Active Ingredients	glyphosate, triclopyr	glyphosate, triclopyr	glyphosate, imazapyr	glyphosate, imazapyr, sulfameturon
# of Acres	5,170 775	8,252 3,100	5,946 1,764	3,802 2,985 27
Amount (gallons)	3,496	6,348	unknown	1,994
% of active ingredients of total solution	6.2%-12.5% 7.8%-12.5%	6.2%-12.5% 7.8%-12.5%	9.4%-12.5% 0.3%	9.4%-12.5% 0.1%-0.3% 0.3%

Source: BPC application records

Champion voluntarily buffers aerial applications of herbicides exceeding the standard recommended by the Maine Pulp and Paper Association. The buffers are designed to reduce the impacts of spray drift to non-target areas. The guidelines call for no spraying in:

- the area within 250 feet of a critical area designated by the Maine Board of Pesticides Control, and
- the area within 75 feet from the high water mark of water bodies that are mapped or visible from the air at 1000 feet.

During the same period, Georgia Pacific Corporation did not apply any aerial herbicides to its forests in the Dennys and East Machias river watersheds.

Insecticides

The use of insecticides varies with the intensity of an infestation. Currently insecticide use statewide is at an ebb, however, entomologists and foresters anticipate the cyclical return of forest damaging insects. The following table **(currently unviewable)** shows the most common forest insects that are treated with insecticides in an attempt to control populations and eliminate the damage they cause.

According to state officials, spraying for the Browntail moth and the White Pine Weevil would be small scale and would only have a chance of affecting the Ducktrap and the Sheepscot River watersheds. State entomologists believe the Spruce Budworm will not return to Maine forests for over 10 years. The

Passamaquoddy Indians treated 18,000 acres with *bacillus thuringiensis* (Bt) for Hemlock looper control in 1991 and again in 1992. This is the most recent insecticide application on record with the BPC in an Atlantic salmon river watershed (upper Machias)

Other insecticides that have been used for forest spraying in Maine in Atlantic salmon river watersheds in recent years or are registered with the BPC for use are listed on the left **(currently unviewable)**.

The most commonly used insecticides have been Bt (Dipel J or Foray J), mexacarbate (Zectran J), aminocarb (Matacile J), and carbaryl (Sevin J). Sevin-4-oil J , Zectran J , and Matacile J were the sprays of choice during the spruce budworm infestation in the 1970's and 1980's with Bt gaining favor amoung forest managers during the later part of the outbreak. Zectran and Matacile are no longer registered and thus unavailable for use. Considerable research was conducted in Canada and in Maine concerning the environmental effects of carbaryl and Bt. The basic conclusion of the work is that carbaryl is toxic to highly toxic to aquatic organisms (Trial 1986). A 1978 paper revealed Atlantic salmon and brook trout brain activity was depressed following the application of Sevin-4-oil J (Hulbert 1978). Additionally, many of the studies noted sharp increases in aquatic insect drift following carbaryl applications. Another study in 1981 confirmed the effect of carbaryl on fish brain activity (Haines 1981). Because of the overwhelming evidence of carbaryl's negative side effects and the alternatives now available, foresters anticipate its future use will be limited to small scale, specific applications.

By contrast, other studies have shown Bt to be relatively benign in an aquatic environment. Neither changes in benthic densities nor aquatic drift were reported in studies following Bt applications for spruce budworm (Trial 1986). Direct effects on fish from Bt exposure are not mentioned in the literature. Barring the development of new controls, state entomologists believe that Bt will likely be the insecticide of choice during the next infestations of Spruce Budworm, Hemlock Looper, and Gypsy Moth. However, Bt is totally ineffective on some pests and other materials may be necessary. Bt might not work on an increasing and severe budworm population such as in the late 70's (Bt formulation are far more effective now but untested under severe conditions). Also, when insects kill huge volumes of wood at a rapid rate, value judgments seem to change with regard to risk to non target organisms versus resource loss.

Appendix 5

Regulatory Standards

Mandatory Shoreland Zoning Act (38 MRSA ' 483-A et seq.)

Standards

Timber harvesting in the shoreland zone (06-096 CMR 1000(O)):

1. In a shoreland zone surrounding a great pond within a resource protection district, timber harvesting shall be limited to the following:

- a. no harvesting except to remove safety hazards within 75 ft of the high water mark.
- b. basal area requirements for areas between 75 ft and 250 ft from the high water mark.

2. In other shoreland zone areas, including coastal waters and wetlands, timber harvesting shall conform to the following provisions:

- a. Selective cutting of no more than 40% of the total volume of trees 4-in. in diameter at breast height (4.5 ft) within a 10 year period. In addition,

  i. within 100 ft of a great pond classified as GPA or a river flowing to a great pond classified GPA, and within 75 ft of other water bodies and wetlands, there shall be no clearcut openings and well distributed stand of trees shall be maintained; and

  ii. in shoreland areas outside those noted above, clearcut openings shall not be greater than 10,000 sq ft in the forest canopy. All clearcut openings greater than 5000 sq ft shall be at least 100 feet apart.

- b. Timber harvest exceeding the 40% maximum above may be allowed upon application to the planning board including a forest management plan prepared by a licensed Maine professional forester.
- c. No slash shall be allowed to within 50 ft. of the high water line of a water body. In all other areas, slash shall be removed to height of 4 ft.. Any debris below the high water line shall be removed.
- d. Timber harvesting equipment shall not use stream channels as travel routes except when frozen or the activity will not result in any ground disturbance.
- e. All crossings of flowing water shall require a bridge or culvert, except in areas with low banks and channel beds which are composed of gravel, rock or similar hard surface which would not be eroded or otherwise damaged.
- f. Skid trail approaches to water crossings shall be located and designed so as to prevent water runoff from directly entering the water. Upon completion of the harvest, all temporary bridges and culverts shall be removed and areas of exposed soil revegetated.
- g. Except for water crossings, all skid trails and other sites where the operation of timber harvest machinery exposes mineral soils, a 75 ft unscarified strip of vegetation shall be maintained on slopes of up to 10% between the exposed mineral soils and the upland edge of water bodies or wetlands. This strip shall increase by 20 ft for every increase in slope of 10%.

Road construction in the shoreland zone (06-096 CMR 1000(H)):

a. Roads and driveways must be setback at least 100 feet from the normal high-water line of great ponds classified as GPA and rivers flowing to these ponds, and 75 from the normal high-water line for other water bodies and wetlands, unless no other reasonable alternative exists in which case the local planning board may reduce the setback to 50 feet and impose other erosion and sediment control measures;

b. On slopes greater than 20%, the setback shall be increased by 10% for every 5% increase in slope;

c. Existing public roads may be expanded within the legal right-of-way regardless of its setback from the waterway.

d. New permanent roads are not permitted within the shoreland zone along Significant River Segments, except to provide access to structures or if no reasonable alternative route exists;

e. New roads and driveways are prohibited in Resource Protection district except to provide access to permitted uses or if no reasonable alternative exists;

f. Road banks shall be no steeper than 2:1 and shall be graded and stabilized according to required erosion and sediment control measures;

g. Road grades shall be no greater than 10% except for segments less than 200 feet;

h. Roads shall be designed, constructed and maintained to empty onto an unscarified buffer strip at least 50 feet plus two time the average slope and runoff onto the strip shall be diffused to increase infiltration and decrease channelization;

i. Ditch relief shall be installed to direct drainage to an unscarified buffer strip before the flow gains sufficient volume or head to erode the road, including size and spacing requirements;

j. Ditches, culverts, bridges, dips and other stormwater control structures shall be maintained on a regular basis.

Natural Resources Protection Act (38 MRSA ' 480-A <u>et</u> <u>seq</u>.)

Permit-by-Rule Standards

Soil disturbance within 25-100 feet of a water body or wetland (06-096 CMR 305(2)):

a. photographs of the site must be taken before and after the activity has commenced;

b. a vegetated buffer strip is maintained 25 ft from high-water mark and 100 ft on slopes greater than 20%, except for new road crossings and other activities that are governed by the standards for those specific activities;

c. existing vegetation within the 25 ft setback shall remain undisturbed;

d. hay bales or silt fencing must be placed in setback areas which are not vegetated;

e. no soils shall be disturbed when saturated due to rain or snow;

f. erosion control measures shall be in place before starting work;

g. all disturbance activities must begin and end within a one month time frame;

h. disturbed soils shall be stabilized upon completion of work or suspensions longer than 1week;

i. hay or straw mulch shall be applied at a rate of 1 bale per 500 sq. ft.;

j. mulch shall be anchored;

k. additional erosion and sediment control measures shall be taken when erosion or sedimentation occurs;

l. temporary stabilization measures shall continue until permanent stabilization measures are in place;

m. permanent revegetation shall occur immediately upon project completion or, if temporary measures were used, within 30 days;

n. lime and fertilizer shall be applied in limited amounts; and

o. erosion and sedimentation control measures should comply with Soil Conservation Service and/or Soil and Water Conservation District specifications.

Stream crossings via bridge or culvert for all streams, rivers or brooks (06-096 CMR 305(10)):

a. spans over navigable waters require a height of 4 feet above high water for navigation;

b. for streambeds with a slope greater than 2%, a bridge or pipe arch is required in order to avoid disturbing the natural gradient;

c. sideslope gradients must be maintained between 3:1 and 1.5:1;

d. alteration of a flood plain wetland is allowed for road crossings up to 100 feet from the high water mark;

e. bridges and culverts must have a cross sectional size 2.5 times greater than the stream channel or big enough to allow for passage of 10 year flood waters, except these may be smaller if accompanied by techniques which mitigate erosion and sedimentation (e.g. water bars, road dips, or removal when frozen);

f. road surfaces shall be constructed to prevent erosion of sediment into the protected natural resource;

g. vegetated filter strips shall be used adjacent to crossing approaches;

h. stream fords shall be lined with natural or synthetic materials to prevent erosion;

i. stream fords shall allow fish passage and normal stream flow;

j. culverts shall be as short as possible, follow the alignment of the stream gradient, outflow at or below stream bed level, be seated on firm ground or synthetic material, covered by compacted soil, have stabilized inlet and outlets;

k. no soil shall be disturbed when saturated due to rain or snow;

l. erosion controls measures shall be installed and maintained prior to commencing an activity;

m. soil shall be stabilized immediately upon completion of the activity;

n. hay or straw mulch, when used, shall be applied at a rate of one bale per 500 sq. ft.;

o. mulch shall be anchored;

p. other techniques shall be used to prevent sedimentation where necessary (i.e. erosion occurs of water is discolored);

q. permanent revegetation of disturbed areas is required upon project completion (Note: erosion and sedimentation control measures should comply with the Maine Erosion and Sediment Control Handbook for Construction: Best Management Practices);

r. no wheeled or tracked equipment shall be operated in the water except to cross streams on rock, reach into water from shore;

s. no work shall be done during times of high water, except to protect work in progress;

t. diversions are required for work in streams less than 3 ft deep; and

u. lime and fertilizer application rates are limited.

Land Use Regulation in Unorganized Territories (12 MRSA ' 681 et seq.)

Standards

Timber harvesting (LURC Rules, Ch. 10.17.A.5):

a. skid roads and trails may not use unfrozen stream beds in protection districts except to cross streams via culvert or bridge which complies with the stream crossing standards;

b. clearcuts are prohibited within 50 feet of the high water mark in P-SL1 and P-GP subdistricts and timber harvesting shall be limited within this area to protect water quality and "reasonably avoid sedimentation" of surface waters;

c. the size of clearcuts are limited in areas greater than 50 feet from the high water mark of streams;

d. total volume of harvesting is limited in ten year periods;

e. slash is prohibited within 50 ft. of high water in streams and great ponds in protection districts, and is limited to 4 ft above the ground;

f. vegetated filter strips must be maintained between machinery operations and water bodies;

g. slash may not be left below high water;

h. skid trail and roads may not use unfrozen stream channels in protection districts except to cross in the shortest possible route, unless the crossing uses a culvert or bridge in accordance with the requirements for stream crossings and then only in stream beds composed of gravel, rock or other hard surface;

i. skid roads and trails shall be located and designed to divert water and prevent direct runoff to streams;

j. timber harvests in shoreland protection subdistricts upstream from the point where they drain 300 acres or less may be excepted from erosion control requirements if they do not cause sedimentation in excess of 25 Jackson Turbidity Units measured where such stream drains one sq. mi. or more;

k. harvesting in shoreland protection subdistricts downstream from the point where they drain 300 acres or more and along standing bodies of water shall maintain shading of surface waters;

l. written notice of timber harvests shall be given to LURC prior to commencement; and

m. other measures shall be taken in order to "reasonably avoid sedimentation of surface waters".

Roads and water crossings in Protection Districts (LURC Rules, Ch. 10.17.A.4)

Construction and Maintenance of Roads:

a. Soil stabilization within 75 feet of a water body;
b. Road bank slope limits;
c. Roads and drainage ditch filter strips; and
d. drainage ditch specifications.

Water crossings when surface waters are unfrozen:

a. Bridges and culverts size;
b. culvert design and installation specifications;

c. ditch maintenance requirements; and
d. other measures which "reasonably avoid sedimentation of surface waters".

Road construction in Management districts (LURC Rules, Ch. 15):

a. plan to locate roads to avoid sensitive areas (e.g. steep slopes, wetlands and mountain areas); minimize stream crossings; and minimize the grade of the road.
b. provide erosion control according to guidelines;
c. provide drainage ditches as needed;
d. stabilize slopes to prevent erosion and slumping;
e. provide vegetated filter strips in widths that vary with the slope, according to a table;
f. drainage ditches for roads approaching water crossings should be designed to discharge onto an unscarified filter strip and provide such other measures as needed to prevent sedimentation of the waterbody;
g. culvert and cross drainage should be designed according to guidelines;
h. erosion and drainage structures must be maintained to ensure proper operation until the road is abandoned.

Guidelines for Soil Stabilization (LURC Rules, Appendix B).

These guidelines apply to any project that requires erosion control under the land use standards or by individual permit.

Appendix 6

ESTIMATED COSTS OF HABITAT ASSESSMENT

(post September 30, 1996)

This Information is currently unveiwable.

J. Recreational Fishing and Natural Threats

I. Introduction

This report presents the recommendations of Maine's Atlantic Salmon Task Force's Recreational Fishing Working Group regarding existing recreational fishing on the seven rivers proposed for listing [60 Fed. Reg. 50532 (September 29, 1995)]. The Fisheries portion of the report (Table 1) discusses the potential threats posed by legal catch and release angling for Atlantic salmon, illegal harvest of Atlantic salmon (poaching), freshwater and estuarine recreational and commercial fisheries, and fisheries assessment activities. The section also provides an overview of freshwater sport fish distributions in the seven rivers and reviews existing recreational and commercial fisheries regulations.

The second part, Ecological Interactions, discusses threats to Atlantic salmon from natural, introduced, or enhanced fish and wildlife populations. This section also evaluates threats to Atlantic salmon recovery from predation, competition, hybridization, and habitat alteration for selected fish or wildlife populations (Table 2). Tables 1 and 2 list (1) management changes or activities that are proposed to reduce the threat and promote recovery of salmon populations, (2) responsible entity, (3) costs, (4) implementation date, (5) rationale, and (6) alternatives not selected. Table 3 lists the time-sequenced implementation schedule for activities to promote salmon recovery and reduce incidental take.

II. Fisheries

A. Recreational Fishing

1. Directed Atlantic Salmon Angling

The Atlantic Salmon Authority regulates Atlantic salmon angling in the inland and coastal waters of Maine. A catch and release Atlantic salmon season is open from May 1st to September 15th. Lower sections of the Dennys, East Machias, Machias, Pleasant, Narraguagus, Ducktrap, and Sheepscot Rivers are open through October 15. Sections of some of these rivers have a shorter season or are closed to angling (Appendix 1). The catch-and-release regulation requires that Atlantic salmon must be "immediately released and returned alive, without further injury to the water from which it was taken." Anglers must purchase an Atlantic Salmon License to legally fish for Atlantic salmon in inland and designated coastal water by fly fishing only. The remainder of coastal waters are open to unlicensed general angling with no harvest of salmon allowed.

Atlantic salmon license sales have declined almost every year since 1990 when 3,299 licenses were sold (Baum et al. 1995). In 1995 the Maine Department of Inland Fisheries and Wildlife issued 1,481 resident, non-resident, and native American Atlantic salmon licenses. As of July 1996, anglers applied for 1,074 Atlantic salmon licenses. The 1995 license sales were less than one fourth of the highest sales, 6,584, in 1982 (Baum et al. 1995). Declines in license sales reflect declines in angler success and effort. On the Narraguagus, in June of 1981 or 1982 a minimum of 15 anglers could be found fishing the traditional pools. In June of 1994, no more than five anglers fished the same pools (Beland et al. 1995).

Combined, historic rod catches for Atlantic salmon on the seven rivers have been as high as 500 fish. However, in recent years estimated catches have not exceeded 100 fish. In 1994 and 1995, rod catches ranged from 0 to 5 fish on the Sheepscot, Ducktrap, and Pleasant Rivers, while catches on the Narraguagus, East Machias, and Dennys Rivers were between 12 and 30 fish (Baum et al. 1995).

2. Potential Threats to Atlantic Salmon

Until 1994, legal sportfishing harvest was a potential threat to Atlantic salmon populations, with harvests of up to 25 percent of runs common. Although harvest is no longer legal, limited mortality can occur from directed catch-and-release angling. Later, this report will assess risks associated with directed catch-and-release angling as justification for the proposed changes to the existing regulations.

Poaching is a continuing concern with a potentially severe population effect. Adult Atlantic salmon taken by poachers would otherwise have had a very high likelihood of spawning. Historically, poachers illegally harvested adult salmon in fresh water (early May - late October) usually in July and August when fish were concentrated in a few well known holding pools and cool water areas. While poaching is known to have occurred in the past, it was at a time when possession of harvested salmon was permitted and when there was no local commercial source for salmon. The current level of Atlantic salmon poaching, as tracked by summonses issued by wardens, is very low. There have been four cases between 1992 and 1996 all in the Penobscot and Kennebec drainages. In contrast, during the mid 1980s there were 10-15 cases per year, many of which were in the seven rivers of concern. However, enforcement actions may not be a reliable indicator. Nevertheless, angler reports and enforcement patrol observations do not indicate evidence of poaching activities since the catch and release regulations went into effect in 1994 and salmon became readily available commercially. Considering the $500 per fish penalty attached to illegal taking activities and the ready availability of salmon products from aquaculture, the threat to Atlantic salmon from poaching, while of legitimate concern, is only a possibility rather than a reality under present circumstances.

3. Actions (letters and numbers in the margins relate to Table 1-3)

RF1 Catch-and-release fishery

1) during stream temperatures of less than 20° C (see Wilkie, et al, 1996)

2) on lower portions of rivers only from April 1st - June 15th, Sept. 15th - Oct. 15th

3) all recreational anglers must purchase a salmon license to fish for any species in these areas

4) use of barbless or pinched barbed hooks only for all anglers

5) with no nets allowed

6) without removing the fish from water (see Ferguson and Tufts, 1992)

7) with mandatory data reporting

8) closure of selected portions of each river to all angling from June 16th - Sept. 14th

This report proposes a catch and release fishery limited in time, space, and angling methods for the seven rivers under consideration. The reasons are that: a) the risk of mortality, from a properly managed catch and release fishery, is very low; b) catch and release angling can be compatible with a continuing program to collect broodstock for the river-specific stocking program; c) the minimal risks are considered to be acceptable when balanced with the benefits to the Atlantic salmon resource from angler presence on the streams and their involvement in its conservation and management and d) the known availability of river specific fry and the development of aquaculture raised broodstock ensures that the rivers will be saturated with fry, thus the minimal incidental take of salmon from a catch and release fishery will have no impact on recovery. The Atlantic Salmon Authority may consider a special reason for the angling of river specific aquaculture raised adults if such angling will not jeopardize wild adults.

Scientists have recently published evidence documenting lower mortality rates for Atlantic salmon from hooking than previously suspected. Owen (1995) reported "average" mortality rates covering all studies (and temperatures) prior to ca. 1992-1994 for all salmonids to be 3.8% for fish caught on a fly and released. However, most studies investigating the effects of catch and release on salmonids used hatchery-reared rainbow trout "exercised to exhaustion" in a laboratory setting (Milligan and Wood 1986a; Wood et al 1983; Graham et al. 1992). By contrast, a series of more recent studies specifically used wild Atlantic salmon in field (i.e. in-stream angling) and in laboratory settings (Tufts et al. 1991; Booth 1994; Booth et al. 1995; Wilkie et al. 1996). In these studies, salmon either angled to exhaustion or exercised to exhaustion at experimental temperatures of 6°C, 12°C and 18°C exhibited 0% mortality. This indicates that properly conducted and controlled catch and release could result in very low to zero mortality.

Booth et al. (1995) noted that fish that had been angled to exhaustion immediately prior to spawning in late fall showed no delayed mortality, nor any reductions in egg production or subsequent egg viability when compared to non-angled control fish. These recent studies with wild and hatchery-reared Atlantic salmon indicate that although the magnitude of changes in physiological variables for salmon and rainbow trout was similar, wild Atlantic salmon typically showed faster recovery rates than trout. Species differences, physical condition of the experimental animals, and temperature may account for differences in mortality rates between the recent studies and earlier work. Similar studies of angling effects on kelts also yielded no mortality during the spring fishery (Brobbel et al 1996).

Some mortality was documented in these recent studies. In Brobbel's 1996 study 3 of 25 [12%] bright grilse died following angling at 16±°C. The study attributed these angling mortalities to predisposed stress during the grisle's physiological transition from saltwater to freshwater. Risks from this type of mortality can be managed using season dates and sections of rivers open to angling. Other mortality observed in these series of studies included 2 of 25 salmon angled on the Upsalquitch River, and one of nine fish angled in the LaHave River in Nova Scotia. In the Upsalquitch study, the two fish that died were part of a group of 10 fish held after angling in a holding tank for "several days to several months." During the same observation period, researchers held the remaining 15 fish in a river barrier pool without mortalities. Thus, the mortalities in the Upsalquitch study are likely the result of long term confinement and not from the effect of catch and release. On the LaHave River, the one of nine fish that died was "the one fish that was angled above 23°C" (Rossiter et al. In prep).

Although some mortality may occur in a catch and release fishery, the newest scientific data specifically addressing wild Atlantic salmon indicates mortality rates are lower for Atlantic salmon than values previously reported, and that managing the fishery by limiting it to a range of environmental conditions can reduce even further any risk of mortality. Tufts (unpublished Final Research Report 1996) noted that "in view of this growing pressure on Atlantic salmon stocks, fisheries managers and conservation organizations (e.g. Atlantic Salmon Federation) have realized that catch and release angling is undoubtedly one of the best methods to sustain and enhance this economically important activity. Our results also indicated that closure of catch and release fisheries during periods of high water temperatures (> 20°C) may be a useful conservation strategy for fragile Atlantic salmon stocks since mortalities after exhaustive exercise/angling are increased at these elevated temperatures (Wilkie et al. 1996)."

Angler presence and involvement have an obvious benefit to Atlantic salmon. Historically, sports anglers have been, and still are, intolerant of activities that threaten "their" salmon. They have been insistent on social and governmental conduct that protects this resource. They have promoted regulation of activities that pose a threat to "their" resources. Anglers have reported observed and suspected violations and complained of ineffective enforcement. Anglers have insisted on scientifically-based and professionally directed management programs supported by their license and tax dollars. Continued discussions (e.g January 1997) with anglers from salmon and trout organizations across Maine have reinforced the importance of maintaining some form of catch and release angling to maintain public support necessary to implement successful management programs.

The positive benefits from a carefully regulated catch and release fishery for Atlantic salmon far outweigh the low likelihood of mortality resulting from catch and release fishing. We expect catch and release anglers to be a presence on the salmon streams, supporting and enhancing conservation measures. Indeed, if the history and the success of resource conservation organizations, e.g. Ducks Unlimited, Wild Turkey Federation, Whitetails Unlimited, etc., is any indication, the continuing involvement of anglers in the organizations they support such as the Atlantic Salmon Federation, New England Salmon Association, Project SHARE, Down East Salmon Federation and local sportmen's clubs will play a key role in successful Atlantic salmon conservation and restoration.

RF2 Increase enforcement presence on Atlantic salmon rivers.

DIF&W will direct all Game Wardens with patrols in the seven drainages to give priority to Atlantic salmon protection. In addition, this report proposes two seasonal Game Warden positions to increase enforcement in the seven drainages. All other game Warden positions in the seven drainages are currently staffed.

RF3 Increase penalties for poaching - loss of hunting and fishing privileges.

RF4 Monitor known cold-water Adult Atlantic salmon holding areas for angling activity, use of illegal gear, and poaching. Close to all fishing as necessary.

4. Alternate Actions Considered.

1. a. A phase-in catch and release angling program based on the percentage of minimum escapement of adults returning to each river: unacceptable because prohibitions on angling for other species is unenforceable and the loss of local volunteer conservation efforts.

   b. No regulations for Atlantic salmon angling: unacceptable.

   c. Directed harvest of salmon: unacceptable.

   d. Directed harvest for grilse only: too great a loss of reproduction.

   e. Catch and release with current regulations: risks loss of production

   f. No angling for salmon: unenforceable. Negative effects on volunteer conservation efforts.

B. POTENTIAL FRESHWATER AND ESTUARINE SPORT FISHING CONFLICTS

The Maine Department of Inland Fisheries and Wildlife (DIF&W) uses lake and river specific seasons, minimum lengths, and possession limits to manage fisheries. Regulations on the seven rivers also include closed areas (Table 4). For two inland fishing seasons, from April 1 through either September 30, October 31, or November 31; and from ice-in through March 31, the regulations require a freshwater fishing license. There are 61 fish species inhabiting Maine's freshwater lakes and rivers. Maine anglers regularly pursue 20 of these species (DIF&W 1990). On a statewide basis, brook trout, landlocked Atlantic salmon, lake trout, and brown trout are the predominant coldwater species. Of these coldwater sport fish, lake trout fisheries are entirely lacustrine; the other species can support fisheries in both riverine and lacustrine habitats. The most popular warmwater sport fish are smallmouth bass, largemouth bass, white perch, and chain pickerel.

In general, during the open water period, early season trout angling occurs in May and June, followed by bass and pickerel fishing on most of the seven rivers. DIF&W administrative Region C assesses and manages freshwater fisheries resources within the Narraguagus, Pleasant, Machias, East Machias, and Dennys River watersheds. Region B is responsible for freshwater fisheries in the Sheepscot and Ducktrap River watersheds. MacDonald et al. (1996) estimated that 19,741 anglers fished streams in Region B during 1994 and 12,206 anglers fished 3800 miles of flowing water in Region C. Based on angler effort, bass were the most sought after sport fishes in Region B streams; followed, in order of effort expended, by pickerel, white perch, brown trout, and brook trout (MacDonald et al. 1996). Region C stream fisheries were predominantly for brook trout, followed by fisheries for bass, smelt, pickerel, and landlocked Atlantic salmon in descending order of effort expended (MacDonald et al. 1996).

The Department of Marine Resources (DMR) requires no license, and fishing is open year-round for most estuarine and marine sport fishes. Smelt, striped bass, mackerel, bluefish, and several species of flatfish are popular recreational fishes of the estuary. For sport, fishers on commercial "party boats" pursue haddock, pollock, and cod. Management of certain species includes minimum length and daily bag limits. In addition, for striped bass there are closed seasons in spawning areas and gear restriction during portions of the open season (Appendix 2). Currently, a 14" minimum size limit exists for all species of salmonids (except brook trout = 6") in the tidal waters of the State of Maine. Salmonid catches in the lower estuaries are usually incidental to angling for other species. Exclusive of Atlantic salmon, there are directed fisheries for salmonids in the upper estuaries of the Kennebec River, Royal River, Ogunquit River, and minor coastal drainages with sea-run populations of brook trout along the coast.

1. Freshwater Sportfish Distribution

Both riverine and lacustrine populations of white perch, chain pickerel, and smallmouth bass are present in the Sheepscot, Ducktrap, Narraguagus, Machias, East Machias, and Dennys watersheds. There are no chain pickerel in the Pleasant River drainage, however, white perch and smallmouth bass are both present. Unauthorized individuals introduced largemouth bass into the Sheepscot, Ducktrap, and East Machias watersheds in past years. The population in the East Machias resulted from an illegal introduction during the 1970's and has spread to eight lakes in the watershed.

Brook trout are indigenous to all seven Atlantic salmon drainages, with both lacustrine and riverine populations. In general, brook trout abundance in rivers is low to moderate, with higher densities occurring in cool-water tributaries. Landlocked salmon populations are present in nineteen lakes in the Sheepscot, Narraguagus, Pleasant, Machias, East Machias, and Dennys River watersheds. Each of these lakes has a low level of natural reproduction occurring in tributary or outlet streams. Only nine lakes have populations that support fisheries for landlocked salmon: Schoodic Lake in the Narraguagus watershed; Pleasant River Lake in the Pleasant River watershed; Mopang and Bog Lakes in the Machias watershed; Love and Gardner Lakes in the East Machias watershed; and Meddybemps, Cathance and Pleasant Lakes in the Dennys watershed. Except for Pleasant River Lake, where the relic population of landlocked salmon is sustained by natural reproduction, fishery biologists sustain populations through regular stocking programs, some which began in 1937 or earlier. In 1995 splake (hybrid: ♂ brook trout X ♀ lake trout) were stocked in seven lakes; one lake in each of the Sheepscot, Narraguagus, and Pleasant River watersheds and four lakes in the Machias River watershed. Brown trout are stocked in Patrick Lake, East Machias and Machias River watersheds and in Bog Lake. In addition to populations in four lakes, three of which are stocked, there is a self-sustaining population of brown trout in the Sheepscot River (DIF&W, Stocking and Lake Inventory files). Figures 1-7 show the locations of potential landlocked salmon, brown trout, and splake interaction with wild Atlantic salmon in the seven river watersheds.

2. Population Monitoring

Population estimates of fish species in Atlantic salmon habitat have been done primarily through electrofishing and spawning observations by the Maine Atlantic Salmon Authority. The Atlantic Salmon Authority has historical electrofishing data from 1950-1996. Although most data are collected to provide juvenile salmon abundance data, a notable exception is two years of work for the Narraguagus (1993-94) that provides estimates of non-salmon abundance at nine sites throughout the drainage (Beland et. al. 1994). Based on the 1993 data only, salmon represented approximately 75% of the fish captures at the sites sampled. At all sites, either salmon or eels represented the greatest biomass. Bass were found at lower river sites only (size range 45-210 mm). Although a few pickerel were found, the number captured was very low. Non-predator fish species were numerically abundant at most sites, but because most of these species (e.g. shiners, dace, etc.) achieve a terminal size that is smaller than age 1+ salmon parr, impacts from competition probably are greater on age 0+ salmon than on older ones.

For other drainages, qualitative electrofishing data exist only for species other than Atlantic salmon. River-reach specific differences in species abundance are apparent within and between drainages.

Observations suggest that the upper Machias (i.e. 3rd Lake Stream) and most reaches in the East Machias have higher levels of bass than other areas. Atlantic Salmon Authority biologists have recently observed bass >12 inches below the dam at Meddybemps Lake on the Dennys River, and salmon anglers in the lower Dennys have complained of hooking more bass in salmon pools in recent years. The Sheepscot River has both species of bass, but neither is abundant. Atlantic Salmon Authority biologists rarely obtain chain pickerel while electrofishing salmon habitat in any of the seven river drainages; however, they usually capture eels. Sites immediately downstream of barriers (falls, dams) have higher abundance of eels compared to other sites. Other freshwater species documented by Maine's biologists while electrofishing the seven rivers are brook trout (mostly occurring at cool-water sites or in the fall), blacknosed dace (and occasionally other dace species), creek chubs, fallfish, shiners spp., common suckers, and occasional sunfish and bullheads.

While electrofishing in the Sheepscot River below Maine Department of Inland Fisheries and Wildlife's Palermo fish rearing station, Atlantic Salmon Authority biologists routinely caught brown trout (age 0+ and

1+) along with salmon. Maine Department of Inland Fisheries and Wildlife has documented natural reproduction of brown trout in this river reach. Fishery biologists have not captured splake while electrofishing, although they have observed at least one in a known springhole used by adult salmon during the summer.

The following figures are currently unavailable to view:
Figure 1. Sheepscot River watershed showing locations of potential interactions between Atlantic salmon (ATS) and either landlocked salmon (LLS), brown trout (BNT) or splake (SPK).
Figure 2. Ducktrap River watershed showing locations of potential interactions between Atlantic salmon (ATS) and either landlocked salmon (LLS), brown trout (BNT) or splake (SPK).
Figure 3. Narraguagus River watershed showing locations of potential interactions between Atlantic salmon (ATS) and either landlocked salmon (LLS), brown trout (BNT) or splake (SPK).
Figure 4. Pleasant River watershed showing locations of potential interactions between Atlantic salmon (ATS) and either landlocked salmon (LLS), brown trout (BNT) or splake (SPK).
Figure 5. Machias River watershed showing locations of potential interactions between Atlantic salmon (ATS) and either landlocked salmon (LLS), brown trout (BNT) or splake (SPK).
Figure 6. East Machias River watershed showing locations of potential interactions between Atlantic salmon (ATS) and either landlocked salmon (LLS), brown trout (BNT) or splake (SPK).
Figure 7. Dennys River watershed showing locations of potential interactions between Atlantic salmon (ATS) and either landlocked salmon (LLS), brown trout (BNT) or splake (SPK).

3. Status of Riverine Fisheries

The Maine Department of Inland Fisheries and Wildlife Region C is 4,021 square miles in area with approximately 3,793 miles of streams. Approximately 29 percent of Region C (1,162 square miles) is in the Narraguagus, Pleasant, Machias, East Machias, and Dennys River watersheds. Within Region C, an estimated 2,845 miles of stream support brook trout fisheries; 73 miles support landlocked Atlantic salmon fisheries (5 rivers/streams); and 129 miles (16 rivers/streams) contain brown trout populations (Maine Dept. of Inland Fisheries and Wildlife 1985). During the 1994 open water season 39,473 angler days (an average of 10 angler days per mile annually over a 180-day season) were expended fishing for brook trout in Region C streams (MacDonald et al. 1996). Angler catch rates averaged 2.52 brook trout/day, with anglers harvesting 1.4 fish/day. The survey did not record any brown trout angling on streams in Region C (MacDonald et al. 1996). Landlocked Atlantic salmon catch rates were 1.47 fish/angler day and harvests were 0.01 fish/angler day. An estimated 7,964 angler days were expended fishing for landlocked Atlantic salmon on rivers and streams in Region C (MacDonald et al. 1996). For the 1993 season, angler effort on Region C's most popular landlocked Atlantic salmon riverine fishery, the first 2.8 miles of Grand Lake Stream, was 762 angler days (DIF&W data).

Region B covers 3,965 square miles with 3,598 miles of streams. The Sheepscot and Ducktrap River watersheds are approximately 6.6 percent of the region (262 square miles). Within region B, 41,036 angler days were expended on brown trout angling in six streams (69.5 miles), including 4.5 miles on the East Branch of the Sheepscot River. Catch rate for brown trout in region B streams was 0.26 fish/angler day, with harvest of 0.01 fish/angler day. Angler effort on one 1.6 mile section of the Sheepscot River, which supports a brown trout fishery, was 3,600 angler days for the 1987 season (DIF&W data). DIF&W regulates this section of the Sheepscot (from the Palermo Lake Dam to the Route 105 bridge in Somerville), requiring (1) artificial lures only, and (2) catch and release angling only for salmon, trout, and togue. These regulations minimize hooking injury of juvenile Atlantic salmon and ensure that anglers do not harvest juvenile salmon. An estimated 35,330 angler days of effort were expended attempting to catch brook trout on the 720 miles of trout streams in Region B. Catch rates averaged 1.15 fish/angler day with an average harvest rate of 0.5 fish/angler day (MacDonald et al. 1996).

The amount of angler use directed at freshwater salmonids in the five rivers in Washington County (Narraguagus, Pleasant, Machias, East Machias, and Dennys) is relatively low, primarily because they are not located near population centers. The most heavily utilized stream in eastern Maine, Grand Lake Stream with its popular fishery for landlocked salmon, probably has less than one fourth of the effort expended in the special regulation section of the Sheepscot River. Angler use on the five Washington County rivers and their tributaries is only a small fraction of that documented for Grand Lake Stream.

Similarly, effort on most of the Sheepscot River and the Ducktrap Rivers is far less than that on the section of the Sheepscot River with brown trout.

Warmwater fisheries on streams in the two regions in 1994 were predominately for bass; with 86,813 angler days expended in region B and 33,019 angler days in Region C (MacDonald et al. 1996). Catch rates were 1.37 fish/angler day in region B and 2.84 fish/angler day in Region C. Harvest rates were less than 0.10 fish/angler day in both regions (MacDonald et al. 1996). In both regions there were fewer pickerel anglers than bass anglers, and harvest rates were 0.02 (B) and 0.05 (C) fish/day, although average catch rates were close to one fish/day.

4. Potential Threats to Atlantic salmon

Fishery biologists have never determined the numbers of Atlantic salmon killed each year resulting from recreational fishing for other freshwater and estuarine species. Anglers may misidentify juvenile salmon as brook trout, brown trout, landlocked salmon, or rainbow trout (even though rainbow trout do not occur in the seven watersheds). During winter, anglers may take an overwintering adult Atlantic salmon believing it is a trophy landlocked Atlantic salmon or brown trout. We are aware of small numbers (from three to ten) of Atlantic salmon kelts taken by winter anglers annually in lakes within the seven watersheds. There is also a risk of hooking mortality when freshwater or estuarine anglers catch, properly identify, and release juvenile or adult Atlantic salmon.

For anglers to catch Atlantic salmon while fishing for other species, it must be residing in the same habitat as the targeted species and vulnerable to the gear being used. Anglers seldom catch salmonids when targeting either bass, pickerel, white perch, or estuarine fish. When brook trout, brown trout, and Atlantic salmon (either anadromous or landlocked) inhabit the same river reaches, catch rates for the species vary with season, relative populations of the species present, and angler behavior. Maine game wardens reported that instances of anglers taking smolts while trout fishing are rare although some early season trout anglers may incidentally hook smolts. Further evaluation of incidental hooking of smolts needs to occur. After smolts emigrate, remaining juvenile salmon are primarily age 1 parr which, at lengths of 3-4 inches, are generally too small to be vulnerable to angling. By the end of June, water temperatures in the seven drainages have warmed, resulting in brook trout leaving the riffles to find cool-water summer refugia. Most salmon parr remain on the riffles throughout the summer.

This partitioning of habitat limits competition between brook trout and Atlantic salmon, and results in almost total curtailment of fishing by trout anglers, further reducing the potential for hooking of salmon parr once they have grown to a size where they would be catchable by August and September. By late summer, when juvenile salmon have grown to 5-6 inches in length, and would be vulnerable to hooking, wardens reported that there was a small group of transient, mostly non-resident anglers who (1) fished during this period, (2) fished primarily at bridge crossings, (3) caught salmon parr, and (4) occasionally kept salmon parr through misidentification, thinking they were either a brook trout, brown trout, or rainbow trout.

Hooking mortality of landlocked Atlantic salmon in a river during late June at water temperatures of 14-19° C was 35 percent with worms and 4 percent with flies (Warner and Johnson 1978). These rates are applicable to juvenile Atlantic salmon because there was no difference in mortality of sub-legal and legal sized fish. Mortality rates were related to anatomical hooking location, with 83% of gill-hooked fish and 72% of fish hooked in the esophagus dying after being caught on worms. Lake studies of mortality of landlocked salmon (Warner 1978) showed no statistical difference in mortality between trolled treble-hooked (8%) lures when compared to single-hook lures (15%). There was no significant difference between mortalities from salmon caught on artificial lures when compared to streamer flies. These studies suggest that to reduce hooking mortality, an artificial lure only regulation is appropriate, but prohibitions on treble-hooked lures are not justified.

In past years some anglers have kept Atlantic salmon grilse in the rivers during the summer and post-spawning kelts in lakes in the winter by improperly identifying them as large landlocked salmon rather than as Atlantic salmon. Because biologists must positively identify an Atlantic salmon as a sea-run rather than a landlocked salmon using microscopic analysis of fish scales, anglers on Maine's rivers and lakes had a loophole allowing them to take Atlantic salmon. Currently, anglers can possess an Atlantic salmon greater than 25 inches and claim it is a landlocked salmon. Unless wardens observed anglers taking such a fish from one of the seven rivers, a regulation on those rivers only would be unenforceable.

Striped bass anglers have reported catching adult Atlantic salmon in estuaries. With an increase in striped bass populations, anglers fishing for striped bass in the seven river estuaries may begin to incidentally catch adult Atlantic salmon with increasing frequency. Adult Atlantic salmon are migrating through the estuaries at approximately the same time as striped bass are arriving in search of prey. While the Atlantic salmon are not feeding themselves, the chances of a striped bass angler foul hooking an Atlantic salmon increases as the activity increases.

5. Actions

RF5 Change fishing regulations on the seven rivers and their major tributaries beginning in July and extending through the open water season (from 7/1-9/30) to artificial lures only. Minimum length on trout = 8 inches after June 30th.

The proposed new regulations will reduce hooking mortality of Atlantic salmon caught incidentally by anglers targeting bass, pickerel, and trout; regulations will prohibit using worms during the late-summer period when some age 1+ parr would be large enough to be vulnerable to hooking.

Evaluate levels of use and impact of early season trout and salmon angling on incidentally catching smolts. Adjust regulations as appropriate.

Evaluate and consider striped bass regulation changes.

RF6 A new regulation establishing a 25-inch maximum length on landlocked salmon will be promulgated in Washington County (except on Spednic Lake, East and West Grand Lakes), as well as on Sheepscot Pond to preclude future lawful harvests of Atlantic salmon kelts by winter anglers. Salmon conservationists will seek a 25-inch maximum length on landlocked salmon and brown trout on the Sheepscot and Ducktrap River watersheds.

6. Alternatives Actions Considered

a. No change in freshwater or estuarine regulations: unacceptable.

b. Closure of fishing for freshwater and estuarine sportfishes in the rivers and estuaries. The threats from these fisheries to Atlantic salmon are not significant enough to warrant total closure of all fisheries.

c. Shorter maximum length limits on landlocked salmon (20", 23") were considered for specific rivers to protect both Atlantic salmon grilse and multi-sea-winter salmon. This regulation would not have been practical for all of Washington County.

C. COMMERCIAL FISHERIES

Commercial fisheries for white sucker, alewife, and American eel in the seven watersheds are under the jurisdiction of both the DMR and the DIF&W. Regulations require permit/licenses for commercial harvest of these species with the issuing agency, depending on whether the fishery is in tidal or freshwater riverine habitat. The white sucker fishery occurs in April and May and targets upstream migrating mature adults. DIF&W issued only one permit for commercial sucker harvest in freshwater on the seven rivers in the spring of 1995. DIF&W issued a permit to trapnet alewives in freshwater for the Dennys River, and DMR regulated alewife fisheries on the East Machias (dip net) and Narraguagus Rivers. On the Narraguagus, fishers attached a trap above the exit of the fishway in the ice control dam. Only small fish like alewives can swim through the entry grates; salmon cannot enter. From April to June, elver fishers use dip and trap nets to catch elvers as they move upstream. Elver fishing effort has greatly increased since 1994, with as many as 20 fyke nets on the East Machias River and more than 30 on the Machias River in 1995. In 1996 marine wardens reported upward of 80 fyke nets in the combined East Machias and Machias estuary. Nets are set at, or slightly downstream of, the head of tide. Fishers use weirs and pots to capture resident and emigrating eels. In 1996 regulators placed a moratorium on new weir sites. In addition, fishers may not relocate weir sites without prior approval of the Department of Inland Fisheries and Wildlife. There will be two weirs permitted for operation in 1996; one at the outlet of

Crawford Lake (Pokey Dam) in the East Machias watershed and one at Coopers Mills on the Sheepscot River.

There are no established fisheries for other marine species near the mouths of the seven rivers that would pose a risk of incidentally taking Atlantic salmon. Specifically, there are no functional herring weirs, no stopseining for herring, no gillnetting, and no marine fisheries for alewives or shad.

1. Potential Threats to Atlantic salmon

Fishers attach elver nets to the shore in a manner designed to capture upstream migrating 2-3" long elvers. Elver nets may capture small numbers of migrating salmon smolts and adults. Maine law prohibits the setting of any fyke nets in the center 1/3 of the river channel. As adult salmon migrate upstream, there may be a chance of encountering an elver fyke net. A new 1996 Maine law requires that elver nets must be made incapable of catching fish from noon Saturday to noon Sunday to comply with weekly closed-period requirements to permit desired escapement levels of elvers.

Biologists have not documented the numbers and timing of Atlantic salmon intercepted by eel, sucker, alewife and other commercial fisheries; however, anecdotal evidence suggests that it is rare. Legally, Atlantic salmon cannot be taken in nets inside the 200-mile limit, although a Maine game warden knew of an anecdotal report of one adult salmon caught in an elver net in 1995. Wardens and biologists of Inland Fisheries and Wildlife in the Machias area know of only two Atlantic salmon taken in marine commercial fishing activities during the past 20 years.

2. Actions

RF7 DMR and DIF&W will monitor different aspects of the American eel fishery to determine if additional regulations are necessary to protect both young and adult Atlantic salmon. With the moratorium on eel weirs in effect, there will be no new weirs in the seven watersheds for the next five years.

Maine Department of Marine Resources wardens will be asked to investigate whether any of the life stages of salmon are being taken in elver nets. Excluder panels will be recommended.

RF8 No sucker harvest permits will be issued in freshwater on any of the seven watersheds.

3. Alternative Actions Considered

a. Do not permit commercial fisheries for American eel (elver or adult) or alewife in any of the seven river watersheds. This alternative was not chosen because it is unduly restrictive.

D. FISHERIES ASSESSMENTS OF ATLANTIC SALMON

The Atlantic Salmon Authority and the Maine Department of Inland Fisheries and Wildlife (DIF&W) conduct fisheries assessments using a wide array of gear, including weirs, fishway traps, electrofishing, gillnets, trapnets, seines, and angling. These activities are conservation measures that promote the restoration of the species (e.g. broodstock collection) or aid in our understanding of population dynamics and ecology.

The Atlantic Salmon Authority may collect brood stock for restoration purposes on any of the seven rivers any time the fish are in freshwater. Fish are collected either as parr (electrofishing) or adults (weirs and traps). In addition, the Atlantic Salmon Authority and DIF&W monitor populations using electrofishing that could result in lower levels of fish mortality. The National Marine Fisheries Service and the Atlantic Salmon Authority began smolt migration studies on the Narraguagus in spring 1996. Biologists collect fish using rotating screw traps for population estimates and implant transmitters for telemetry studies.

The Maine Atlantic Salmon Authority (formerly the "Commission") historically conducted stocking programs on all seven rivers, and before ca. 1992, biologists stocked various life stages (fry through smolt) in these rivers. Importantly, however, the source of stocked fish may not have been the river where fishery biologists introduced the reared fish. The Authority adopted a "river-specific" stocking policy in

1992. Since then, an aggressive broodstock development program has been in place, and broodstock and fry are now available for five of the seven rivers (excluding the Pleasant and Ducktrap). The management goal of the Authority for these rivers is to saturate nursery habitats in all five rivers (Baum et al. 1995), and broodstock and fry for all five rivers are currently available to stock at levels ranging from 72% to100% of target levels as set by the Technical Advisory Committee of the Atlantic Salmon Authority in 1996. Similar levels will be reached in 1997.

1. Potential Threats to Atlantic salmon

The potential for mortality of juvenile and adult Atlantic salmon exists as a result of fisheries sampling and assessment activities by Atlantic Salmon Authority and Inland Fisheries & Wildlife as well as brood stock collection by the Atlantic Salmon Authority and federal agencies. Fishery biologists design these activities to be non-lethal forms of sampling. Although the potential for mortality exists, they expect death from electrofishing to be only between 0.1 and 0.3 percent of the juvenile population (Schill and Beland 1995). The Atlantic Salmon Authority and U.S. Fish & Wildlife Service have been collecting parr for use as captive broodstock since 1992. Post-capture survival and fertility of these fish have been very high. In addition, modeling demonstrates that the effects of electrofishing mortality in a small portion of the habitat does not affect the population within an entire drainage (Schill and Beland 1995). This is because fish biologists sample less than 10 percent of the habitat and sampling mortality and natural mortality is probably compensatory rather than additive.

2. Actions

RF9 Fishery biologists will take every possible precaution to reduce mortality from fisheries assessment. DIF&W and ASA biologists will keep records of all mortalities. If mortality occurs that is not outweighed by the potential benefit to salmon conservation, then biologists will discontinue the activity immediately.

III. Ecological Interactions

A. OTHER SALMONIDS

1. Potential Threats to Atlantic salmon

Brook trout are native to all seven watersheds. Resource managers have used introductions of splake, brown trout, and landlocked Atlantic salmon to increase angling opportunity in several waters within the seven watersheds. Figures 1-7 show the distribution of these salmonids in the seven rivers and the following presents their potential threats to Atlantic salmon.

Brook Trout

Brook trout are indigenous to all Atlantic salmon drainages and have coevolved with Atlantic salmon. Due to water temperature regimes occurring in the major salmon-producing habitats within the seven river watersheds, the primary period for competition, when both salmon and brook trout use the same riffle habitats, lasts only a few weeks, from early May through late June. Once water temperatures approach 18-20°C, brook trout leave the riffles in search of cooler water, while salmon remain throughout the summer. Long-term electrofishing studies on Washington County rivers by staff of the Maine Atlantic Salmon Authority and the Maine Department of Inland Fisheries and Wildlife have shown that brook trout rarely inhabit Atlantic salmon juvenile nursery habitat from July-September. Gibson (1993) noted that brook trout and Atlantic segregate habitats resulting in little competition as under-yearlings. Fishery biologists do not consider brook trout to be a significant predator on Atlantic salmon because most trout do not attain the size where piscivorous foraging greatly increases (> 10 inches). Habitat partitioning during most of the growing season limits the opportunity for interaction between brook trout and juvenile salmon.

Landlocked Salmon

Landlocked salmon are present in lakes within the Sheepscot, Narraguagus, Pleasant, Machias, East Machias, and Dennys watersheds. Although some landlocked salmon may spawn on habitat that Atlantic salmon also use, landlocked salmon spawning occurs on a relatively minor scale in terms of available

Atlantic salmon habitat within the watersheds. The possibility of hybridization exists on the upper Dennys River below Meddybemps Lake. Biologists have observed both landlocked salmon and Atlantic salmon there during mid-October. There is almost no potential for hybridization on the headwaters of Cathance Stream, due to the rare occurrence of Atlantic salmon in this section. Chase Mill Stream has a section of salmon spawning habitat measuring about 100 yards long that both Atlantic salmon and landlocked salmon have used for spawning for more than 60 years. Field observations by Maine's Atlantic Salmon Authority and Inland Fisheries and Wildlife staff biologists have produced only one observation in more than 20 years where Atlantic salmon and landlocked salmon were seen attempting to spawn together (Ken Beland, Me. Atlantic Salmon Authority, personal communication). However, biologists have commonly observed both species in the same habitat during spawning. Predation by adult landlocked salmon, if it occurs, would be expected only during periods of (1) cool water temperatures before landlocked salmon move to either nearby lakes or (2) during periods of higher flows when larger landlocked salmon might temporarily reside near nursery habitat. Observations and angler surveys by ASA and DIF&W biologists suggest that this competition and predation issue is minor.

Splake

Splake stockings by Maine Department of Inland Fisheries and Wildlife have been successful only where an adequate volume of cool water (12-16° C) habitat is available in a lake. Splake have not survived in lakes where cool water is absent. Tim Obrey, the Maine Department of Inland Fisheries & Wildlife biologist, responsible for splake management and research, reports that splake usually reside in the upper levels of the hypolimnion. Due to the warm summer water temperatures found in Maine's Atlantic salmon rivers and streams, fishery biologists would not expect splake to grow well and survive unless they resided in habitat with cool spring water inflow. Although fishery biologists have documented splake migrating out of lakes to temporarily reside in stream or river habitat, subsequent recoveries have usually shown them to be in substandard condition (Black Brook and Sheepscot River). An exception has been that a splake residing in a cool-water springhole in a streams was in better condition. Overall, densities of splake in streams have been very low in comparison to densities of Atlantic salmon and brook trout.

Although splake are a fertile hybrid, and splake reproduction is reportedly possible, Maine biologists have yet to document its occurrence. Observations during the fall spawning period are ongoing and will continue in the future. We do not know whether splake spawning in Maine would occur in flowing water, similar to brook trout, or in lake shore habitat, similar to lake trout. Studies in the Great Lakes have shown that splake spawned only on lake trout spawning shoals. Although Tim Obrey and colleagues trapnet splake annually at Maine's Piper Pond, they have never observed any splake reproduction or naturally produced juveniles, even though they have captured both male and female splake.

Brown Trout

Resource managers have stocked brown trout in lakes having minimal potential for impact on Atlantic salmon production in the watersheds of the Washington County rivers. Each of these lakes has a small, shallow outlet with extremely low summer flows. Further, each of these lakes is at least 5 miles from any Atlantic salmon spawning or nursery habitat. Patrick Lake is located in the East Machias watershed, far from any Atlantic salmon spawning or nursery habitat. Its small outlet represents only a minor attraction for stocked fish to leave the lake. Bog Lake is located in the Machias River watershed. Its outlet is small, characterized by many beaver dams, and has negligible flow except during high-water periods. Fish biologists do not expect brown trout to leave the lake. Six-Mile Lake flows into the Machias River estuary. Its outlet is very small and intermittent, with no outflow during dry periods of the year. Due to the low numbers of brown trout that would attempt to leave the lakes and to the low probability that they could travel to any salmon spawning area, there is virtually no potential for brown trout to breed with Atlantic salmon, although it has occurred in Nova Scotia (Beland et al. 1981) and Great Britain (Jordan and Verspoor 1993).

There is no incidence of capturing a brown trout by the Atlantic Salmon Authority while electrofishing in any salmon drainage other than the Sheepscot. For several years, resource managers stocked the East Branch of the Sheepscot River, below Sheepscot Lake with spring yearling trout. The result was a self-sustaining population with some individuals reaching lengths of 16 inches (J.D.McNeish, regional fisheries biologist, personal communication). Stocking ceased in 1994. Although competition could potentially limit smolt production from this section of Sheepscot River, fish biologists expect the overall drainage-wide impact to be small because of the small amount of habitat where brown trout occur. They believe brown trout presently occupy up to six percent of the salmon habitat in the drainage. While brown trout could prey on Atlantic salmon juveniles in the Sheepscot River, most brown trout reside in the headwater section below Sheepscot Lake where few Atlantic salmon spawn.. Therefore, biologists do not believe predation and competition from brown trout represent a problem even in this watershed. The probability of hybridization in the upper portion of the Sheepscot where brown trout and salmon share spawning habitat is higher than in any of the other rivers.

2. Actions

RF10 Fishery biologists will screen the outlet dam at Meddybemps Lake each fall to prevent landlocked salmon from leaving the lake to spawn.

Maine biologists will monitor salmon habitats by electrofishing to ensure that brown trout are not inhabiting Atlantic salmon habitat as well as check stomachs of any brown trout captured to determine whether they prey on juvenile salmon. If problems of competition or predation are found, resource managers could cease stocking brown trout prompting populations to disappear.

Maine biologists will monitor splake movements using electrofishing and trap nets to determine whether splake are inhabiting Atlantic salmon habitat in significant numbers. If splake were found to reside in salmon habitat in numbers sufficient to present a potential problem of competition, resource managers could stop stocking splake thereby extirpating their populations.

3. Alternate Actions Considered

a. Cease or alter brown trout stocking program. This alternative was not chosen because the lakes with brown trout are not deemed to present a problem to salmon.

b. Stop splake stocking. This was not chosen as because present knowledge on their habitat use has not shown this to be a necessary action at this time.

c. Alter current landlocked salmon stocking programs. This was not chosen due to the relatively limited impact of landlocked salmon on Atlantic salmon in these rivers.

B. PREDATORS

1. Potential Threats to Atlantic salmon

There are a variety of mammalian, avian, and fish predators of Atlantic salmon which may contribute to Atlantic salmon natural mortality at different life stages from eggs to adults. Potential predators of Atlantic salmon in freshwater and the upper estuary include: otter, mink, seal, cormorant, belted kingfisher, common and hooded mergansers, American eagle, osprey, loon, great blue heron, smallmouth and largemouth bass, chain pickerel, creek chub, fallfish, American eel, yellow perch, and striped bass, and some species of macroinvertebrates that may eat eggs and alevins in the redds and newly emerged fry.

During the past 20 years, anglers and biologists have observed seal bites on adult Atlantic salmon caught in the Washington County rivers. Atlantic Salmon Authority staff records suggest that on the Penobscot River as many as 11 percent of adults entering the trap at the fishway have seal bites (several hundred fish examined each year). On the Narraguagus River between 1991 and 1995 there were two years when when biologists or anglers did not see seal bites on fish captured in the fishway trap (n=52 and 56). For the other three years seal bites occurred on between 2.1 (n=46) and 6.9 (n=72) percent of the fish (ASA file data). Anglers watching the tidal sections of these rivers have observed seals surface with adult Atlantic salmon in their mouths. While impossible to quantify the scope of this predation problem, it occurs late in the salmon's life cycle and potentially has more impact at a population level than other forms of predation.

The abundance of double-crested cormorants in Maine has shown a dramatic increase since the early 1950's (Krohn et al. 1995), in part because federal law has protected cormorants for more than 15 years. People rarely saw cormorants in eastern Maine 45 years ago, but their numbers increased by the late

1960's. It is common to observe from several dozen to a few hundred cormorants in the lower river and upper estuary of the seven downeast rivers during May when smolts are migrating. Documented predation on stocked smolts in the Machias River ranged from 0.3 to 9.5 percent during the period 1966 to 1970 (Fletcher et al. 1982). Fishery biologists removed fifty-five Atlantic salmon smolt tags from the stomach of one cormorant (Fletcher et al. 1982). The bird was shot five hours after daylight. Biologists had stocked smolts the previous evening after cormorants had returned to roosts. On the Penobscot River, birds collected above head of tide consumed 12 different fish species. Those collected below head of tide had a diet that included 28 species (Blackwell et. al. in preparation). Spatial and seasonal variation in prey abundance greatly influenced diet, with smolts most important in the diet in May when stocked smolts were emigrating (Atlantic Sea Run Salmon Commission 1986-89). The extent of cormorant predation on wild Atlantic salmon smolts has not been as firmly established as that for hatchery-reared smolts.

The greatly increased management efforts to augment the level of salmon production in freshwater and promote recovery makes it highly important that smolts migrate to the ocean without the risk of predation from substantial numbers of cormorants in several sections of the river and estuary. Lacking cormorant control, much of the increased production from freshwater may be lost before smolts reach the open ocean.

Habitat quality, water quality, overwinter survival, and intra- and inter-specific competition are considered the major constraints on freshwater production of Atlantic salmon (Gibson 1993). Predators may affect habitat use, but seldom limit Atlantic salmon populations in freshwater. Elson documents one exception in the 1962 report that on the Pollett River where mergansers were the limiting factor in smolt production (Elson 1962). For good smolt production to occur, mergansers should not exceed 1 per 50 acres of water surface in the river. Although female common mergansers and their broods are observed feeding in salmon habitat in Maine rivers, their populations are probably below the 1/50 acres threshold. A greater diversity of alternate fish prey also occurs in Maine rivers. Belted kingfishers occur sporadically along the rivers but are not numerous. Both mink and otter are opportunistic. Wildlife experts expect them to feed on fish other than salmon. Neither mammal seriously preys on Atlantic salmon. Habitat partitioning between warmwater fish species (bass, chain pickerel, yellow perch) and parr probably limits predation in rearing habitat. Fishery biologists know little about Atlantic salmon predation by American eel, fallfish, creek chub, and other fish species commonly found in Atlantic salmon habitat.

Predators may play more of a role in population dynamics during migratory phases. Atlantic salmon smolts school, a predator defense behavior, while migrating out to sea. On the Narraguagus River, chain pickerel can remove substantial numbers of smolts as they pass Beddington Lake (Barr 1962). Bass also may be less efficient predators at the time of smolt migration (Van den Ende 1993). Cormorants can be a major predator on Atlantic salmon smolts.

Chain pickerel and smallmouth bass occur in many sections of the seven rivers. While habitat differences between these warmwater species and salmon parr minimizes pickerel predation on age-0+ and age-1+ parr in nursery habitat, researchers have documented predation on migrating smolts (Barr 1962, Van den Ende 1993). Atlantic salmon smolts were the most important dietary item of chain pickerel (11.5 - 24 inches in length) during the smolt run period on the Penobscot River, where 58 percent of all pickerel stomachs contained food items and smolts represented 80 percent of the wet weight of all prey items (Van den Ende 1993).

None of the 127 smallmouth bass from 9.5 to 18 inches captured from April 10 through June 17 in the Penobscot River contained Atlantic salmon smolts (Van den Ende (1993). Smallmouth bass were torpid and did not eat either Atlantic salmon smolts or golden shiners at 5°C. At 10°C, bass were more active and responded to prey but were most active in feeding at 15°C. By the time temperatures reach these levels, smolts have left the seven rivers. Van den Ende (1993) concluded that smallmouth bass were probably not a major predator on Atlantic salmon smolts on the Penobscot River due to (1) morphological constraints (small mouth), (2) low feeding rates during the beginning of the smolt run, (3) differential habitat use by each species, (4) anti-predator behavior of smolts, (5) observed selection of small prey rather than large prey by bass, and (6) the fact that bass must be at least age five or older (>11 inches) to be large enough to potentially prey on smolts. By the time smallmouth bass might actively seek smolts as prey, most smolts will have already migrated out of the river.

Striped bass populations have expanded over the last ten years, extending their range into Downeast river estuaries. Furthermore, fishery biologists anticipate the numbers of striped bass to increase over the next several years. Striped bass move into the estuaries seeking prey at approximately the same time that smolts are migrating out of the rivers. These factors mean there will likely be an increase chance of striped bass predation on Atlantic salmon smolts.

1. Actions

RF12 Study the impacts of seals on Atlantic salmon and, if warranted, evaluate the potential effectiveness of seal control at the mouth of rivers during periods of peak salmon migration.

If there are any successful seal deterrent or harassment methods, permission should be granted for their use at and near the mouth of the seven rivers proposed for listing. If the Marine Mammals Protection Act is amended to permit a level of lethal sampling for food habits study on seals, some seals should be sampled at the mouth of the seven rivers proposed for listing.

RF13 Study the impact of double-crested cormorants on wild Atlantic salmon populations and, if warranted, evaluate the potential effectiveness of alternative control programs.

RF14 Study the food habits of American eels collected in juvenile Atlantic salmon habitat.

RF15 Change daily limits on chain pickerel within the mainstems and larger tributaries of all seven rivers to reduce populations that prey on migrating smolts.

Because of the high level of predation on smolts exerted by chain pickerel, the bag limit should be removed on pickerel on each of the seven rivers and their major salmon-producing tributaries. However, it should be noted that due to anglers' lack of interest in harvesting currently allowable daily limits of pickerel, even removal of the daily bag limit is not expected to significantly increase harvest or reduce populations of this predator species.

RF16 No size or bag on bass in the Dennys River and Cathance Stream.

A prior agreement with anglers on the Dennys River will result in Maine's Inland Fisheries and Wildlife Department promulgating a "No size or bag limit on bass" for the Dennys River and its major tributary Cathance Stream, the same regulation as presently exists on the headwater lakes, Meddybemps and Cathance.

C. BEAVER

1. Potential Threats to Atlantic salmon

Beaver are common in the Washington County rivers and cause problems to Atlantic salmon populations through (1) blockage of adult migration in tributaries to the mainstem rivers and (2) flooding of spawning and nursery habitat, rendering it unusable. Habitat loss may be short-term in locations where freshets cause wash-outs of beaver dams. In 1995, approximately 1/3 of all Atlantic salmon spawning habitat in the 7 rivers was potentially inaccessible due to beaver dams that were located downstream of these spawning grounds. The extent of this threat is dependant on the amount of rainfall received during late summer and early fall.

2. Actions

RF17 Current, well-timed breaching activities in key areas by the Atlantic Salmon Authority and the U.S. Fish & Wildlife Service are largely adequate for addressing the problem and these activities will continue. In addition, special consideration will be given to liberalizing seasons, to mapping of specific problem areas to assist trappers in focusing their efforts, and to identifying key areas for higher levels of beaver removal.

D. DISEASE AND PARASITES

1. Potential Threats

The aquaculture report reviews disease and parasite issues related to aquaculture. Maine's state hatcheries operate under a very strict fish health and disease policy. Fish are regularly inspected and tested for diseases by the staff pathologist of Inland Fisheries and Wildlife to virtually ensure that DIF&W's stocked fish will not introduce fish pathogens into any of the seven rivers. This fish health and inspection policy will be extended to private hatcheries in Maine to prevent the possibility of pathogens being introduced to the seven rivers via stockings from private hatcheries into public waters or privately owned ponds in those watersheds.

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Table 1. Potential threats to Atlantic salmon from fisheries activities in seven Maine rivers with Atlantic salmon populations.

Potential Threat	Severity of Impact 1=major 5=insignificant	Action proposed to reduce threat and promote recovery	Potential to reduce threat H=high M=moderate L=low	Action Feasibility	Responsible Entity	Date	Cost	Discussion /Rationale
{RF1} Directed recreational angling for Atlantic salmon	1	Severely limit and release fishery: restrictions on time (May 1-June 15, Sept. 15 - Oct. 15), location (provide an upriver sanctuary for salmon), and gear (no nets, barbless hooks).	M	H	ASA	1997, 1998	$3,500	Minimal anticapted take while allowing a significant ability to maintain public constituent involvement
{RF5} Taking of juvenile ATS by trout anglers who misidentify the species. Currently, BNT and BKT may be taken at a minimum length of 6" in brooks, rivers and streams as a general law in Maine.	2	Change fishing regulations in seven rivers and major tributaries (7/1-8/15) to: ALO minimum length on trout 8"; keep bag limit at 5; 7/1-9/30 current regulations but minimum length on trout is 8".	H	H	IF&W	1998	None	During the late summer period when juvenile ATS are large enough to be vulberable to hooking, the new regulation would result in virtually no salmon parr taken since very few are over 8". ALO during this period would ensure low hooking mortality.
{RF5} Hooking mortality of juvenile ATS caught incidentally by BKT, LLS, and BNT anglers	2	Change fishing regulations in seven rivers and major tributaries (7/1-8/15) to: ALO minimum length on trout 8"; keep bag limit at 5; 7/1-9/30 current regulations but minimum length on trout is 8".	H	H	IF&W	1998	$3,500 total for all rule changes	This will reduce potential hooking mortality from 35% for fish hooked on worms to < 10% on artificual lures.
{RF6} Potential of keeping an ATS kelt taken in a lake by ice fishing as a "large trophy-sized LLS", resulting in the taking of an ATS.	2	Promulgate new regulation establishing a 25" minimum size on landlocked salmon in all of Washington County, except West Grand and East Grand Lakes.	H	H	IF&W	1998	$3,500 total for all rule changes	This would protect all multi-sea-winter ATS from being harvested by ice anglers after spawning.
{RF2, RF3, RF4} Poaching of adult salmon	1	Staff all warden districts in the 7 drainage and hire 2 seasonal wardens. Assign top priority to prevention of poaching for wardens in districts where poaching is likely.	H	M	IF&W, ASA, DMR	1997	$3200/ year	Poaching results in the take of adult ATS that were otherwise virtually assured of spawning. Low returns of ATS coupled with a large supply of aquaculture ATS has probably reduced poaching levels. As runs are

								restored, poaching will likely increase.
{RF8} Potential for incidental taking of ATS adults and juveniles in fyke and/or trap nets used by private citizens in early spring to capture common suckers for lobster bait in ATS rivers and their tributaries	Potential: 1; Actual: 5 (no one currently using nets for this activity	IF&W will not permit this activity in any locations having the potential to catch an ATS.	L	H	IF&W	Ongoing	$20,120	Prohibition on private use of these gear types in the 7 rivers and their tributaries will prevent any incidental catch of ATS.
{RF7} Potential for incidental taking of ATS in eel weirs on ATS rivers	Potential: 1; Actual: 5 (no one currently using weir for this activity)	Only 2 eel weirs are being used on the seven rivers. They have very little chance of catching ATS.	L	H	IF&W	Ongoing	None	This site will be terminated after present permit holder discontinues operations there.
{RF7} Potential for incidental taking of smolts and adult ATS in elver fyke nets.	Presently unknown	Monitoring of the fishery for ATS by-catch will be ongoing. Require exclusion panels.	Unknown	H	DMR,ASA	1997	None.	Little is known about the potential for bycatch of ATS because high levels of effort to capture elvers did not begin until 1995. A Maine Game Warden knows of 1 ATS caught in an elver net in 1995.
{RF5} Hooking mortality of ATS caught incidentally by anglers fishing for PKL or bass.	5	The ALO regulation from 7/1-9/30 will minimize hooking mortality of any ATS that may be hooked by PKL and bass anglers	L	H	IF&W	1998	None	Because most PKL and bass angling does not occur near ATS habitat, and very little habitat overlap with ATS exists, it would be very rare for a PKL or bass angler to hook any life stage of ATS.
{RF9} The potential for take of juvenile and adult ATS exists as a result of normal fisheries sampling and assessment activities by	5	Fishery biologists will take precautions to reduce mortality and keep records of all mortalities	N/A	N/A	N/A	N/A	N/A	This activity must be allowed to continue in order to work towards recovery of species and allow assessment

ASA and IF&W and brood stock collection by ASA.								of inland fish species by IF&W.
{RF5} Incidental take of ATS by marine commercial and sport fisheries	5	Evaluate and consider striped bass regulation changes	N/A	N/A	N/A	N/A	N/A	There is no known take of ATS in any marine fishery in the 7 river estuaries. Currently, minimum lenght for all salmonids caught in coastal waters is 14", except BKT is 6".
{RF6} Taking of ATS kelts in lower Sheepscot River upper estuary and calling it a large adult BNT.	5	Promulgate new regulation establishing a 25" maximum size on LLS and BNT in the Sheepscot River and estuary.	L	H	IF&W, DMR	1998	$3,500 total for all rule changes	This would protect all multi-sea-winter ATS from being harvested by anglers catching large BNT or LLS in the Sheepscot drainage.

Table 2. Potential threats to Atlantic salmon from ecological interactions with fish and wildlife in seven Maine rivers with Atlantic salmon populations.

Potential Threat	Severity of Impact 1=major 2=insignificant	Action proposed to reduce threat and promote recovery	Potential to reduce threat H=high M=moderate L=low	Action feasibility	Responsible Entity	Date	Cost	Discussion/Rationale
{RF10} Genetics issues of potential of LLS and ATS to spawn together; competition for food and space between LLS and ATS on nursery habitat.	5 (overall for 7 rivers); 3 (for 3 specific habitats where both ATS and LLS occur)	Statas quo - no action, except that Meddybemps Lake will be screened each fall to prevent LLS from leaving the lake to spawn just below the lake.	N/A (H at Meedybemps Lake)	N/A (H at Meddybemps Lake)	ASA, IF&W	Ongoing	$200 for adequate screen at upstream end of Meddybemps fishway	Chases Mill Stream has produced both LLS and ATS for decades. Upper-most sections of Cathance Stream and the Dennys River have both LLS and ATS.
{RF12} Adverse effects on harbor seals on adult ATS at mouth of rivers.	1	Study impacts of seals on ATS and obtain permission to control seals at mouth of seven rivers through all available means.	H	L	State and Federal wildlide agencies	ASAP	High	Adult salmon which have returned to the mouths of rivers have a very high chance of surviving to spawn, unless seals or humans cause their mortality.
{RF13} Predation on ATS smolts by double-crested cormorants.	1	Study impacts of cormorants on wild ATS smolts and initiate a well-planned, long-term cormorant control program on the rookeries and upper section of estuaries.	H	L	State and Federal wildlife agencies	ASAP	$50,000	If smolts are to migrate safely from rivers to the open ocean, they must be given adequate protection from cormorant predation.
{RF17} Populations of beavers in the 7 drainages have been increasing leading to serious limitiations of ATS ability to access upstream spawning areas as well as some degradation of ATS habitat through impoundments and subsequent	2	Current activities have been successful in providing access to ATS by well-timed breaching of beaver dams and removal of inactive dams. Trapping seasons in Washington County were extended in 1995/96 in an attempt to liberalize harvest.	H	H	Project SHARE, ASA,IF&W	Ongoing	$3,000	Low fur prices have reduced the level of beaver trapping in most areas of Maine. Animal damage control work is extemely labor intensive and costly and would require almost continual effort to keep beaver populations in check.

stream warming/siltation								
{RF15} PKL predation on smolts can reduce their numbers. The degree to which this occurs depends on the abundance of PKL in areas smolts must migrate through en route to the ocean. The Pleasant River has no PKL, and the Dennys River has few	2 (overall); 5 (Pleasant and Dennys Rivers)	Change daily limits on chain pickerel within the mainstems and larger tributaries of all seven rivers to reduce populations that prey on migrating smolts	L	H	IF&W	1998	$3,500 total for all rule changes	The would permit the most liberalized havest levels potential for PKL. Any reductions in PKL populations would reduce the level of repdation on ATS smolts. Even with this liberalization, few anglers are expected to pursue pickeral intensely.
{RF14} Predation on juvenile ATS by American eels inhabiting ATS nursey habitat	Currently unknown	Sample gut contents of American eels captured which electrofishing juvenile salmon hahitat to determine food habitats.	N/A	H	ASA, ifw	1996	Normal operating budget	American eels are piscivorous and can be very abundant in ATS habitat. Although actual predation on juvenile ATS is undocumented, it may occur.
Competition for food and space between ATS and BKT; predation by larger BKT on juvenile ATS	5	Status quo - no action	N/A	N/A	N/A	N/A	N/A	Habitat partioning during most of the growing season limits interations between these 2 species in the 7 rivers.
Competition for food and space between BNT and ATS; predation on ATS fry and juveniles by larger BNT	5 (overall) 3 (Sheepscot)	Status quo - no action	N/A	N/A	N/A	N/A	N/A	Only possible impact could be the upper portion of the Sheepscot River where some naturally spawning BNT occur.
Competition between juvenile life stages of SMB and ATS; predation by bass on juvenile ATS.	5	Status quo - no action	N/A	N/A	N/A	N/A	N/A	Electrofishing studies by Maine fisheries agencies show that juvenile bass are found on only a very few ATS habitats.
{RF10} Predation on ATS fry, juveniles, or smolts by larger	Presently unknown	Monitor SPK movements to ensure that they are not taking up	N/A	H	ASA,IF&W	Ongoing	$500/year	The only location with the potential for impacts is near Beddington Lake on the

SPK.		residence in ATS habitat and identify Atriggers@ whereby SPK stocking would be halted.						Narraguagus River. SPK are not expected to reside in the river during the summer due to warm temperatures.
Predation on ATS juveniles by larger LLS.	5	Status quo- no action	N/A	N/A	N/A	N/A	N/A	Actual incidence and abundance of LLS in vicinity of ATS habitat is extemely low and limited to 1 tributary to the E.Machias and Dennys Rivers.
{RF10} Migration of BNT out of stocked lakes where competition, predation, and hybredizations could occur	5	Monitor BNT movements to ensure that they are not taking up residence in ATS habitat and identify Atriggers@ whereby BNT stocking would be halted.	N/A	H	ASA&IF&w	Ongoing	$300/year	The 3 lakes in the 5 Washington County drainages where BNT stocked all have very small, shallow, low-flow outlets and are at least 5 miles from ATS habitat.
{RF10} Competition for food and space between SPK and ATS on nursery habitat.	5	Monitor SPK movements to ensure that they are not taking up residence in ATS habitat and identify Atriggers@ whereby SPK stocking would be halted.	N/A	H	ASA, IF&W	Ongoing	$500/year	The only location with the potential for impacts is near Beddington Lake on the Narraguagus River. SPK are not expected to reside in the river during the summer due to warm temperatures.
SMB have not been documented to be a serious predator on smolts, although they occasionally prey on them. The degree to which this occurs depends on the abundance and size of bass in areas that smolts must migrate through.	5	Status quo- no action	N/A	N/A	N/A	N/A	N/A	Van den Ende (M.S. Thesis, 1993, University of Maine, Orono) found that SMB: (1) exhibited a very low predation rate on ATS smolts with none of the 127 bass taken in the Penobscot River during the smolt run having any smolts in their stomachs; (2) did not feedc very actively until the later part of the smolt run period; (3) tended to prey on smaller prey items rather than fish as large as smolts. (4) lost

								smolts from their mouth during laboratory studies due to smolts escaping.

Table 3. Implementation Schedule for Activities to Promote Recovery and Reduce Incidental Take of Atlantic Salmon

Task No. (Time sequenced)	ACTION	Responsible Entity	Target Date
RF7	Monitor elver fyke net bycatch.	Maine Department of Marine Resources, Atlantic Salmon Authority	1997 (April - June)
RF13	Study impacts of cormorants. Evaluate potential of a control program. Count cormorants during smolt run.	Me. IF&W, ASA, U.S.Fish & Wildlife Service, volunteers	1998
RF12	Study impacts of seals. Evaluate potential for deterrent methods. Counts.	Nat. Marine Fisheries Service, ASA	1997, 1998
RF8	Do not issue any permits for private use of trapnets to capture suckers in the 7 river watersheds.	Maine Inland Fisheries and Wildlife	1997
RF11	Monitor splake habitat use.	Maine Inland Fisheries and Wildlife, Atlantic Salmon Authority	1997
RF11	Monitor brown trout habitat use.	Maine Inland Fisheries and Wildlife, Atlantic Salmon Authority	1997
RF4	Monitor known cold-water adult Atlantic salmon holding areas for angling activity, use of illegal gear and poaching. Close to all fishing as necessary.	Maine Inland Fisheries and Wildlife, Atlantic Salmon Authority, University	1997
RF14	Sample gut contents of American eels taken from juvenile salmon habitat.	Maine Atlantic Salmon Authority	1997
RF10	Screen Meddybemps Lake outlet each fall.	Maine Atlantic Salmon Authority	1997 (fall)
RF6	Adopt 25" maximum length on landlocked salmon in Washington County (except East & West Grand Lakes) and Sheepscot River.	Maine Inland Fisheries and Wildlife	1998
RF9	Permit liberal harvest of beaver in the 7 river watersheds. Breach beaver dams seasonally.	Maine Inland Fisheries and Wildlife	1997
RF2	Fully staff all warden districts in the 7 river watersheds; hire seasonal wardens as necessary.	Maine Inland Fisheries and Wildlife	1997
RF1	Adopt regulations regarding fishing for Atlantic salmon	Maine Atlantic Salmon Authority	1997, 1998
RF3	Increase peanalties for poaching	Maine Atlantic Salmon Authority	1997
RF5 RF6 RF15 RF16	Adopt regulations for inland sportfishing: **1)** from 7/1 - 9/30 annually: artificial lures only, 8" minimum length on all trout, daily bag limit on trout and salmon=1 fish in the aggragate **2)** from April 1 - 9/30: no size or bag limit on chain pickerel in 7 rivers and major tributaries **3)** No size or bag limit on bass in Dennys R. and Cathance Stream **4)** 25" maximum length on brown trout in Sheepscot River.	Maine Inland Fisheries and Wildlife	Public hearings: 1997 (summer) Implementation: 1998 (Me. Inland Fish & Wildlife's legal framework starts new non-emergency regulations on even-numbered years only.)

Table 4. Summary of open water fishing regulations on seven Downeast Atlantic salmon rivers.

RIVER	REGULATION
Sheepscot River	From 150 feet below the dam to the upstream (northern) side of the Route 105 bridge in Somerville: Open to fishing from April 1 to Sept. 30: Artificial lures only; Daily limit on salmon, trout and togue: 2 fish in the aggregate; Minimum length limit on trout: 10 inches.
Ducktrap River	Fly fishing only, Daily limit on brook trout: 2 fish; Minimum length on brook trout: 10 inches. River open until Oct. 15 from the confluence of Black Brook to tidewater.
Narraguagus River	1) Closed to all fishing within 100 feet of the ice control dam at Cherryfield. **2)** From 100 feet above the ice control dam and extending upriver approximately 1 3/4 miles to red markers situated on each side of the river: general law fishing, with single-pointed hook (except Atlantic salmon) is permitted from May 1 to Aug. 15; from Aug. 16 to Sept. 30, artificial lures with single-pointed hook (except Atlantic salmon), daily limit on salmon, trout and togue: 1 fish in the aggregate; **3)** Closed to all fishing is that portion of the Narraguagus River from a red marker at the mouth of Sodom Brook in Deblois, downstream approximately 150 yards to a red marker. **4)** Above Deblois bridge, taking of fish is prohibited except by use of a single hook on a line. **5)** Below Deblois bridge, fly-fishing only. 6) See Schoodic Brook. **Schoodic Brook** Closed from red post at its mouth to red post 1,00 feet upstream.
Narraguagus River, West Branch	General Law.
Pleasant River and Tributaries	No size or bag limit on bass. Otherwise General Law.
Machias River and Tributaries	General Law. **Old Stream and tributaries** from Rt. 9 down to Guptill Road, Wesley, T31MD, T25MD. Artificial lures only, Daily bag limit on brook trout: 2 fish; minimum length limit: 10 inches, only 1 may exceed 12 inches.
East Machias River	General Law.
Dennys River	That portion of the Dennys River in the town of Dennysville and Plt. 14 from a red painted marker approximately 100 feet upriver from the mouth of Batson Meadow Spring to a red painted marker approximately 100 feet downriver from Batson Meadow Spring closed to all fishing. **Cathance Stream** - General Law.

GENERAL LAW

SEASON:

April 1 - September 30. (From August 16 - September 30 rivers, brooks and streams have a daily bag limit on salmon, trout and togue of 1 fish, artificial lures only).

MINIMUM LENGTH LIMITS:

Togue: 18 inches; Salmon: 14 inches; Brown trout and Rainbow trout: 12 inches (except on rivers, brooks and streams, where the minimum legal length is 6 inches.) Brook Trout: 6 inches, (except on lakes and ponds in Androscoggin, Cumberland, Kennebec, Knox, Lincoln, Oxford, Sagadahoc, Waldo and York Counties where the minimum legal length is 8 inches); charr (includes blueback and sunapee trout): 8 inches.

DAILY BAG LIMITS:

Salmonids:

5 fish in the aggregate, not to include more than: 2 salmon; 2 togue (lake trout); 2 rainbow trout; 2 brown trout; 2 charr; 5 brook trout (includes splake), except on lakes and ponds in Androscoggin, Cumberland, Kennebec, Knox, Lincoln, Oxford, Sagadahoc, Waldo and York Counties where the daily bag limit on brook trout is 2 fish.

Other Species:

Pickerel: 10; Whitefish: 8; Smelts: 2 quarts. Length limits - none.

BASS REGULATIONS (includes largemouth and smallmouth bass):

April I - June 20, the daily bag limit on bass is 1 fish; artificial lures only; minimum length limit: 12 inches (except in Aroostook, Hancock, Piscataquis and Washington Counties where the minimum length limit on bass is 10 inches in lakes and ponds).

WEIGHT LIMIT:

No person shall take, catch or kill in any one day or possess at any time from any or all inland waters more than 7 1 / 2 pounds in the aggregate of salmon, trout and togue unless the last fish caught increases the combined weight to more than 7 1/2 pounds. This same weight limit also applies to bass.

POSSESSION LIMIT:

No person shall possess at any time more than one daily bag limit.

1996 ATLANTIC SALMON FISHING REGULATIONS

Maine Atlantic Salmon Authority
650 State Street, Bangor, ME 04401-5654
Telephone: (207) 941-4449

ADDITIONAL PHONE NUMBERS
Maine Warden Service**,** Bangor.... 941-4440
(or toll-free 1-800-624-2498)
Maine Marine Patrol, Lamoine.... 667-3373

GENERAL REGULATIONS PERTAINING TO ATLANTIC SEA RUN SALMON

CATCH & RELEASE ONLY: It is unlawful to take or possess any Atlantic salmon from all Maine waters (including coastal waters).

Any salmon caught must be Immediately released, alive and without further injury.

Coastal waters - Open Season: May 1 through October 15.

Closed Season: October 16 to April 30, both days inclusive; it shall be unlawful to fish for Atlantic salmon from the coastal waters by any means. **Note:** Federal rule prohibits the taking of Atlantic salmon in coastal waters between the three (3) mile limit and the two-hundred (200) mile limit.

Inland waters - Open Season: May 1 through September 15. See exceptions marked with an asterisk (*) under Regulations on Individual Waters.

GENERAL REGULATIONS

Method of fishing:

It is unlawful to fish for Atlantic salmon from *inland* waters by any means other *than fly fishing.*

From May 1 to October 15, both days inclusive, it shall be unlawful to fish for Atlantic salmon from the coastal waters by means other than *hook and line.* See exceptions marked with an asterisk (*) under Regulations on Individual Waters.

In all waters of the State (including coastal waters), all Atlantic salmon caught at any time, by any means, of any size, and in any numbers shall be immediately released and returned alive, without further injury, to the waters from which they were taken.

It is unlawful to sell or offer for sale any Atlantic salmon taken from the inland or coastal waters of the State except Atlantic salmon lawfully raised by means of aquaculture.

Violations of regulations of the Atlantic Salmon Authority are punishable pursuant to 12 M.R.S.A., 6204.

REGULATIONS ON INDIVIDUAL WATERS IN THE SEVEN WATERSHEDS

Dennys River Watershed.

All waters and tributaries and adjacent coastal waters inside and upstream from a line drawn from the outer extremity of Leighton Point to the outer extremity of Denbow Point, to the east side of the U.S. Rte. 1 bridge in Dennysville - **open May 1 through October 15 to rod and line fishing.**

From the east side of the U.S. Rte. 1 bridge in Dennysville upstream to the two markers set on the shores of the Narrows in Dennysville - ***open May 1 through October 15 to fly fishing only.**

All wates above the markers at the Narrows - ***open May 1 through June 30 to fly fishing only.**

Machias and East Machias Rivers Watershed.

All waters and tributaries and adjacent coastal waters inside and upstream from a line drawn from the outer extremity of Long Point to the outer extremity of Birch Point, to two Red markers set on the shores of the Machias River downstream from the confluence with the East Machias River - ***open May 1 through October 15 to rod and line fishing.**

From the above-mentioned red markers upstream to two red markers on the shores of the Machias River above the falls in Whitneyville; and from the above-mentioned red markers upstream to two red markers on the shores of the East Machias River at the Gaddis Mill Pool in East Machias - ***open through October 15 to fly fishing only.**

The following tributaries to, and sections of, the Machias River - ***closed after July 15:**

Old Stream and its tributaries upstream from the red marker on the shore of the Machias River at the mouth of said stream.

Mopang Stream and its tributaries upstream from the red marker on the shore of the Machias River at the mouth of said Stream.

Machias River, at the mouth of **Libby Brook**, from a line drawn between two red markers set on the shores of the Machias River approximately 100 feet upstream from the mouth of Libby Brook downstream approximately 300 yards to two red markers set on the shores of the Machias River, this area to include Libby Brook and its tributaries.

Machias River, at the mouth of **Crooked River**, from a line drawn between two red markers set on the shores of the Machias River approximately 100 feet upstream from the mouth of the Crooked River downstream approximately 200 yards to two red markers set on the shores of the Machias River, this area to include Crooked River and its tributaries.

All other waters of the Machias & East Machias rivers **open May 1-Sept 15 to fly fishing only.**

Pleasant and Narraguagus Rivers Watersheds.

All waters and tributaries and adjacent coastal waters inside and upstream from a line drawn from the outer extremity of Petit Manan Point to the outer extremity of Cape Split, to the south side of the Addison bridge on the pleasant River, and to the south side of the U.S. Rte. 1A bridge in Milbridge on the Narraguagus River - **open May 11 through October 15 to rod and line flshing.**

Pleasant River and Tributaries above the main river bridge in Addison: * **Open May 1 - September 15 to fly fishing only.**

Narraguagus River, from the south side of the U.S. Rte.1A bridge in Milbridge upstream to the ice control dam in Cherryfield - ***open through October 15 to** fly fishing only.

All other waters of the Narraguagus River **open May I - September 15 to fly fishing only**

Ducktrap River Watershed.

All waters and adjacent coastal waters inside and upstream from a line drawn from the outer extremity of the Ilsboro Ferry Landing pier in Lincolnville to the outerextremity of Spruce Head in Northport upstream to a line drawn between two red posts set on the shores approximately 1,000 feet downstream from the U.S. Route 1 bridge - open **May 1 through October 15 to rod and line Fishing.**

From the two red posts upstream to the confluence with Black Brook - ***open through October 15 to fly fishing only.**

All other waters of the Ducktrap River - **open May I through September 15 to fly fishing only.**

Sheepscot River Watershed.

All waters and tributaries and adjacent coastal waters inside and upstream from the Wiscasset/Edgecomb U.S. Route 1 bridge, to the downstream side of the Puddledock bridge in Alna - **open May 1 through October 15 to rod and line fishing.**

From the downstream side of the Puddledock Bridge in Alna upstream to the Head Tide Dam in Aina - ***open through October 15 to fly flshing only.**

All other waters of the Sheepscot River - **open May 1 through September 15 to fly fishing only.**

Appendix 3: Proposed new freshwater fishing regulations.

Fishing in the following listed waters shall be as follows:

1. From April 1 to September 30, "No size or bag limit on chain pickerel."

and

2. From July 1 to September 30:

   a. artificial lures only

   b. minimum length on all trout: 8 inches

   c. Daily bag limit on trout: 1

Dennys River from Meddybemps Lake dam to tidewater
Cathance Stream downstream of Cathance Lake

East Machias River from Crawford Lake dam to tidewater
Northern Stream downstream of Love Lake
Chases Mill Stream downstream of Gardner Lake
Beaverdam Stream downstream of South Beaverdam Lake
Seavey Stream

Machias River from outlet of Fifth Machias Lake to tidewater
West Branch Machias River downstream of Lower Sabao Lake
Mopang Stream downstream of Route 9
Old Stream downstream of Second Old Stream Lake
New Stream downstream of Route 9
Crooked River

Pleasant River downstream of Pleasant River Lake
Eastern Little River from origin to confluence

Narraguagus River from outlet of Deer Lake to Route 193 bridge
Baker, Shorey, Sinclair, and Gould Brooks from origin to confluence
Note: Mainstem downstream of the Route 193 bridge <u>will continue to be fly fishing only</u>, but will change to "all trout and salmon must be released at once from July 1 to September 30".

Sheepscot River: From Sheepscot Pond to tidewater and from the outlet of Branch Pond (East Branch) to confluence with mainstem.